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THE MAGAZINE OF MATERIALS ENGINEERING

VOLUME 32, NUMBER 2 — AUGUST 1950

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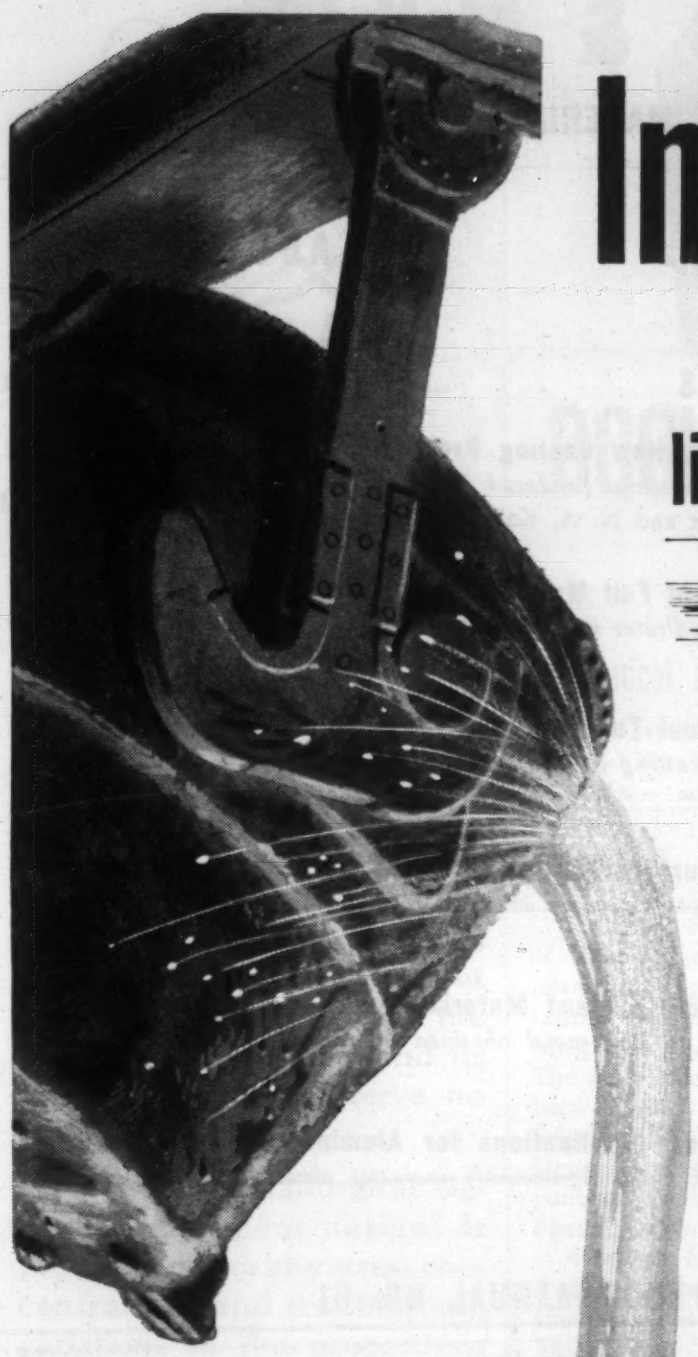

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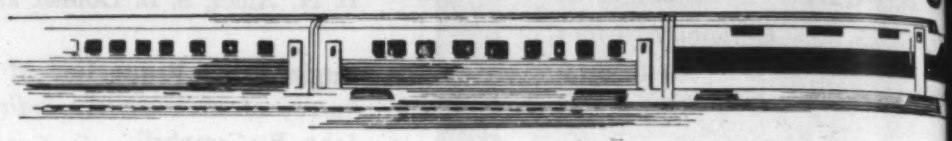

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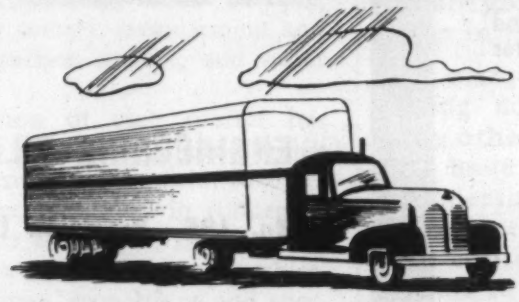

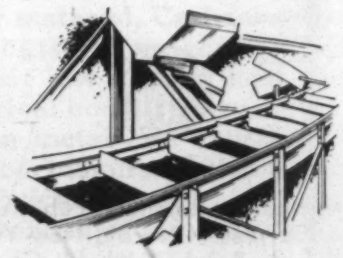

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COMPARISON OF *AVERAGE* PROPERTIES OF HI-STEEL WITH ORDINARY STRUCTURAL GRADE CARBON STEEL

Tensile Properties (¼" Plate)	Inland HI-STEEL	Ordinary Structural Grade Carbon Steel
Yield Point (psi)	56,000	35,000
Ultimate Strength (psi)	73,000	66,000
Elong. in 8" (%)	25	25
Endurance Limit		
Fatigue Strength (psi)	49,000	33,000
Impact Resistance (Charpy Impact—ft. lbs.) Temperature		
80° F	55	36
32° F	43	33
0° F	36	26
—25° F	34	6
—50° F	30	2

The Materials Outlook

o one can tell yet, but the effect of any war effort on our ci-
ilian economy should not be too great for quite a while,
nless fighting breaks out on other fronts in addition to
orea. There are many reasons for this, including the fact
hat several European nations have steel and other metals for
xport, our capacity to produce is greater than ever, and sup-
ly pipe lines of finished consumer goods are pretty well
illed. . . . There is less panic buying in the industrial
ield than is true in foods and consumer goods. Many pro-
ucers are imposing voluntary allocations of materials to
revent the building of unnecessary inventories. By self
olicing, industry might be able to avoid complete government
egulation.

Prior to the emergency in Korea, plans and works nearing completion in the steel industry add up to an increase in capacity of 6,363,000 tons. With other plans now about to be acted upon, the steel industry's capacity is expected to exceed 105,750,000 tons by the end of 1952. The 100,000,000 mark was passed on July 1 of this year.

lthough magnesium and aluminum consumption dropped somewhat
n April and May of this year, the demand will rise sharply
ith increased military expenditures. Much of the antici-
ated increased use will come for a new idea which calls for
he use of magnesium or aluminum sheet for aircraft skins
any times thicker than the skins now used. By using thicker
aterials, internal stiffening can be dispensed with and costs
educed substantially. In wings the new type construction
ill permit additional fuel tank space, and thereby extend the
efulness of the planes.

With the anticipated increase in demand for magnesium, plus stockpiling, there is a strong possibility that some of the standby magnesium plants will be put back into operation. Presently about 30,000,000 lb. of magnesium is produced annually. At the peak of the war, our capacity was 580,000,000 lb. Present capacity, including active plants, is about 250,000,000.

(Continued on page 4)

The Materials Outlook *(Continued)*

One of the newer synthetic industrial fibers, Orlon, is expected to give nylon a run for its money on many types of service. The material has excellent resistance to outdoor exposure; resists action of mineral acids, common solvents, and oils and greases; resists bacterial and insect attack; is strong at elevated temperatures; has good dielectric properties; and a low water absorption rate. The material also has many potential textile uses for clothing and similar applications.

A reduction in the cost of truck trailers might be forthcomi as a result of ten manufacturers standardizing on certain extruded aluminum sections. Shapes such as door frames, longitudinal radius sections, all uprights and roof bows are extruded. Although using uniform extruded shapes, the builders can still vary the design of trailers they produce.

Continued suspension of the import duty on copper for another year is considered a victory by those copper producers and fabricators who do not have domestic sources of copper. Outbreak of the shooting war aided those opposed to the duty, because it would be unwise to limit our ore supplies until we know exactly how much copper we will need.

Many companies which have learned to use shearings, trimmings offal blanks, bar ends and other scrap materials are now finding this a dual blessing. With continued tight supplies, they will find it easier to keep civilian production at a higher level and at the same time continue to save money.

Even though Russia has not sent us manganese for several months, there apparently is no fear of immediate scarcities. However, the situation might spur us on to help other nations extract manganese, chromium and other ores for shipment to this country.

A new type of automotive safety glass will soon make its appearance in a popular make of car. The glass will feature a plastic interlayer that is tinted near the top, with the tint decreasing in intensity through the upper half of the piece. The theory is to provide glare protection and still give a clear view of the road.

A new porcelain enamel is reported to have gone into limited use recently that has such excellent hiding power that it can be used in extremely thin coats. Even though it is a vitreous enamel, the new material is said to be capable of competing on a cost basis with baking enamels.

News Digest

Stainless Steel, Magnesium Figure in Recent Price Hikes

Recent hikes in stainless steel prices have been announced by Carnegie-Illinois Steel Corp., American Steel & Wire Co. and National Tube Co., subsidiaries of United States Steel Corp. Increases were attributed to the recent 8¢ per lb. increase in the price of nickel.

Stainless steel ingots, blooms, billets and slabs for re-rolling as well as tube rounds, were increased 1¢ per lb. by Carnegie-Illinois. The price of hot rolled strip was raised $1.25 per lb., and all other stainless steel products except plates increased $1.50 per lb.

Galvanized Steel Pipe Up

Stainless steel cold rolled strip, cold drawn wire and cold drawn bars were increased $1.50 per lb. by American Steel & Wire, and National Tube increased stainless steel tubular products also $1.50 per lb. In addition, National Tube raised prices on galvanized steel pipe in sizes ½ in. and larger about $6 per net ton.

Wrought Magnesium Products

At the same time, Dow Chemical Co. announced its first price increase for magnesium wrought products in four years. Commercial grade Dowmetal FS extrusions were increased 2¢ per lb., and commercial grade Dowmetal M was increased to equal new FS extrusion prices.

Specification grade FS-1 extrusions were increased 4¢ per lb.; specification grade M extrusions are now priced 2¢ per lb. over new commercial grade M extrusions; and special alloy extrusions were revised upward.

Commercial grade M and FS sheet in mill standard and mill non-standard sizes was increased 4¢ per lb. in all gages 0.032 in. and heavier; specification grade M and FS-1 sheet in the same sizes and gages was increased 6¢.

ASTM Papers Cover Materials Properties, Test Methods

That the American Society for Testing Materials is fulfilling one of its main functions—the promotion of knowledge of materials engineering—was amply demonstrated at the 53rd Annual Meeting held in Atlantic City, June 26-30. In addition to committee reports that covered all phases of materials engineering, nearly 100 technical papers were presented at the five-day session.

Effects of Temperature on Metals

The need to know or predict the effect of temperatures (both high and low) on the properties of metals has become an increasingly important problem. A number of interesting papers were presented at the meeting on this vital subject.

N. A. Ziegler and P. H. Brace discovered that austenitic chromium-nickel steels can be made unusually hard by mechanical working at about —50 F and lower. Hardness can be increased still further by a subsequent aging heat treatment at about 750 F. Their paper was titled "Hardening of Austenitic Stainless Steels by Mechanical Working at Sub-Zero Temperatures."

Results of investigations by V. N. Krivobok and A. M. Talbot on the processing of commercial austenitic stainless steels at sub-zero temperatures show general agreement with those of Ziegler and Brace. Their paper, "Effect of Temperature on the Mechanical Properties, Characteristics and Processing of Austenitic Stainless Steels", covers the mechanical properties at sub-zero and elevated temperatures of steels rolled at room and at sub-zero temperatures. The effects of sub-zero and of elevated temperatures on the properties at room temperature were also determined.

A paper, "Hardened Alloy Steel for Service up to 700 F," by G. V. Smith, W. B. Seens and E. J. Dulis, described the high temperature properties of two steels, SAE 4340 and an 0.40 carbon nickel-chromium-molybdenum-vanadium steel. Among other results, it was found that with increasing temperature, the yield and tensile strengths of both steels decreases. In creep-to-rupture tests, strength also decreased with increasing temperature.

Non-Destructive Testing

Non-destructive testing methods are being looked to more and more for the economical solution of inspection problems in our highly mechanized industry. For this reason, a symposium was conducted by Committee E-7 to acquaint engineers and technical management with the advantages and uses of non-destructive testing.

The opening paper, by R. C. MacMaster and S. A. Wenk, provides an excellent and badly needed "Basic Guide for Management's Choice of Non-Destructive Tests." It summarizes the basic principles and essential parts of non-destructive tests, and gives the significant features of 12 basic test methods. Perhaps of most value is the compilation of 250 patents and 500 technical articles. The patents have been classified by method of testing, and important operating features are tabulated in 24 appended tables.

K. R. Van Horn in his paper described "Defects or Discontinuities That Can Be Revealed in Cast and Wrought Metal Products by Non-Destructive Tests." By use of carefully chosen examples he showed the indications of defects obtained by several different test methods, including

News Digest

radiography, ultrasonics and magnetic particle inspection.

That much time, trouble and money can be saved by use of the right testing method at the right time was demonstrated in the paper, "The Economics of Special Inspection Problems," presented by L. W. Ball. The author cited numerous cases in which the failure to use non-destructive testing, particularly in the development stages of product design and manufacture, caused serious failures and much wasted effort.

The remaining papers of the symposium took up the role of non-destructive testing in the inspection of various types of materials and products. J. W. Juppenlatz in "The Role of Non-Destructive Testing in the Economics of Castings," pointed out that non-destructive testing permits evaluation of the inherent qualities of a casting without destroying its usefulness, and that it will continue to be a force promoting the growth and economic state of the casting industry.

C. D. Moriarty covered wrought steel inspection in his paper, "The Economics of Wrought Steel Inspection." Radiography, he pointed out, is not suited for inspection of wrought steel. Magnetic particle inspection, being primarily a surface test, can be used early in the manufacturing cycle, but its best role is as a final inspection. Liquid penetrant methods on non-magnetic material are similar to magnetic particle tests in this respect. Magnetic analysis methods indicate non-uniform subsurface conditions and can be used where it is not important to distinguish between non-uniformities

(Continued on page 112)

New Gasket Material Developed

Development of a gasket material based on an aluminum foil-laminate bonded with a special synthetic resin has been reported in *Light Metals* (Feb. 1950).

Thickness of individual foils can vary from 0.00394 to 0.0005 in., depending upon the particular application. For most purposes, 1/32 in. seems to be the most effective total thickness of the laminate. The new material is said to flow readily, providing a gas-tight seal; and it is easily fabricated.

Produced by Plexeal, Ltd., Haddenham, England, the gaskets can be used for all purposes where normal gasket materials are required. The high thermal conductivity of the laminate makes it particularly advantageous for the cylinder-head gasket in small internal-combustion engines where heat dissipation is important.

B & W Plans Steel Extrusion Plant

A million-dollar extrusion plant for the fabrication of tubes of ferrous metals and alloys in complex sectional shapes will be built at Beaver Falls, Pa., according to a recent announcement of Babcock & Wilcox Tube Co. The company has been licensed by Comptoir Industriel d'Etirage & Profilage de Metaux of Paris, France, developers of the process and holders of the patent rights.

The French hot extrusion process was described earlier in MATERIALS & METHODS (Mar. 1950, p. 56). It is presently in commercial operation at the Persan plant of C.I.E., a subsidiary of Societe d'Electro-Chimie, d'Electro-Metallurgie et des Acieries Electriques d'Ugine, where it was developed during the war.

Micro Throwing Power Studied as Key to Improved Plating

The possibility of conducting commercial plating operations in such a manner as to improve greatly the quality of the plated coating now seems less remote as a result of information presented at a recent symposium on the smoothing and leveling of electrodeposits. The symposium was featured at the 37th Annual Convention of the American Electroplaters' Society and Fourth International Conference on Electrodeposition, held in Boston in June.

Of particular interest was the paper presented by C. E. Reinhard, The New Jersey Zinc Co (of Pa.), entitled "Some Observations on the Microthrowing Power of Plating Solutions." Defined by the author as the ability to plate more metal in a vo of mil dimensions than on adjace surfaces, microthrowing power found in solutions producing eith dull or bright deposits. The phenom non cannot be the same as that ca ing leveling and brightness.

Mechanically formed grooves a fe mils in dimensions were used in th tests. The factors in the plating oper tion which control microthrowi power were studied and evaluate Best results were obtained with sol tions of high metal content operate at elevated temperature with low cu rent density. Solutions based on co plex ions, such as the ordinary copp cyanide bath, were found to ha little or no ability to plate into fi recesses. Microthrowing power a pears to be an exact opposite of ord nary throwing power in that tho solutions and operating condition giving the best general distribution the coating were found by the auth to have the least microthrowi power.

These new observations are e pected to have considerable influen on future developments in platin An immediate practical applicatio might be the problem of depositi metal in the small surface voids i pressed metal powder parts.

Welding of Tinplate Studied

Results of an investigation of th suitability of resistance welding fo tin- or solder-coated steel sheet an tinplate were published recently b the Tin Research Institute. The wor was done by A. J. Hipperson and P M. Teanby, of the British Weldi Research Assn.

Their investigation of flash an spot methods of resistance weldi showed that principal difficulties wer contamination of the electrodes wi the coating material and lack of co tact resistance at the points to b welded.

With sheet of 0.050-in. thickness all welds attempted were satisfactor Spot welding of tin and tin-zinc coated steels also appears practicable provided electrode tips are properl maintained. Copper electrodes gav good results, but chromium-copper electrodes showed less deformation and were, therefore, recommended Light moving head, short stroke, ef ficient cooling and high welding cu rent were also advised.

Conference Considers Mechanical Properties of Plastics

A three-day conference on the mechanical properties of plastics attracted more than 200 scientists and engineers to Massachusetts Institute of Technology in June.

The first four sessions featured highly technical papers presented by members of the M.I.T. Plastics Group and scientists from Bell Telephone Laboratories, the Naval Research Laboratory, and other companies and institutions. The last two sessions, however, produced a number of papers having general engineering interest; some of these papers will be briefly summarized below.

Plastics Selection

In "Mechanical Properties of Rigid Plastics," Robert Burns, Bell Telephone Laboratories, discussed the principal categories of rigid plastics in relation to their most important engineering characteristics.

Wear resistance varies among the different plastic groups, with nylon, Teflon and the vinyls ranking high, the phenolics and cellulosics intermediate, and the acrylics, alkyds and polystyrene low. Some characteristics of plastics, on the other hand, are almost universally poor. For instance, they have high coefficients of thermal expansion, poor spring characteristics, low impact fatigue strength, and high noise conductivity. Flammability is hard to measure, but it should be kept in mind that all organics burn; therefore, the term "nonflammable" applied to plastics means only "relatively slow-burning."

Burns showed how misleading strict adherence to data sheets could be in selecting the proper plastic for a given application. Despite the gap that exists between data and performance, however, he believes that the much-maligned properties chart, when integrated with mature technical judgment, provides a sound basis for plastics selection.

Once the material has been selected on the basis of both data and experience, he asserted, the designer must rely upon the "know-how" and integrity of the resin producer and of the molder.

Engineering Adhesives

The various factors which should be considered in the selection of an adhesive for industrial application were outlined by F. W. Reinhart, National Bureau of Standards, in a paper entitled "Engineering Adhesives."

In selecting an adhesive, the designer should first be sure that it is strong enough for the required type of service. Then he should specify a joint wide enough to carry the load. In general, adhesive-bonded joints should be designed for shear; cleavage or peeling forces should definitely be avoided. The layer of adhesive should be uniform in thickness. Finally, the adhesive layer should be as thin as possible where good bonding is desired, but thicker if higher impact strength is required.

In joining plastics by adhesives, it is harder to obtain strong bonds with thermosetting materials than with thermoplastics, according to Reinhart. Plastics having good chemical resistance are difficult to bond well at all. For example, no good adhesive has been found yet for either Teflon or polyethylene.

Coatings and Finishes

M. R. Euverard, Interchemical Corp., presented a general review of the variables which must be considered in the formulation and selection of "Protective and Decorative Industrial Finishes."

Among these factors are the nature

News Digest

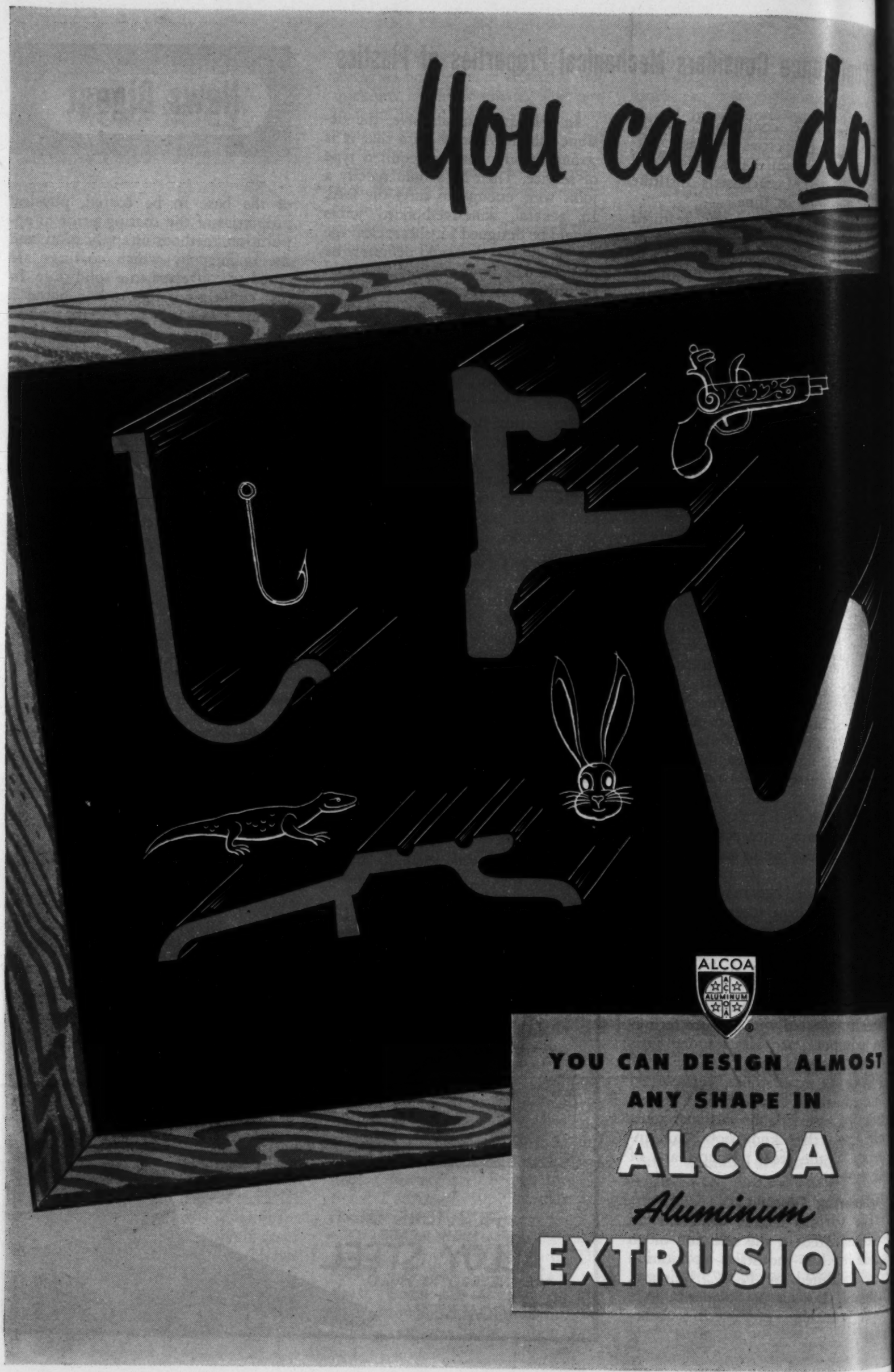
of the base to be coated, physical properties of the coating prior to application, methods of application, and the manner by which coatings are cured or converted to a solid state. In this connection, the author noted a definite trend in recent years toward finishes which can be converted to final form in the shortest possible time by using elevated temperatures.

He also discussed the significance of the three different categories of properties of protective and decorative coatings—appearance properties, accelerated test properties and inherent physical properties. In general, he believes industry is now placing less emphasis on accelerated tests and more on response to actual performance conditions or moderately accelerated conditions.

The author also described a number of tests, including methods for determining both wet and dry film thickness, elastic properties, viscosity and surface tension.

(Continued on page 120)

MATTER OF FACT
EDW. A. JOSEPH
FROM 1860 TO 1870 WHEN THE VOGUE WAS IN FULL SWING
1,500 TONS OF STEEL WIRE
WERE SOLD ANNUALLY FOR MILADY'S
HOOP SKIRTS
THERE ARE MORE THAN 3,200 FASTENERS, INCLUDING NUTS, BOLTS, SCREWS AND RIVETS, IN A TYPICAL PASSENGER AUTOMOBILE
ABOUT FIVE TONS OF HIGH GRADE ALLOY STEEL ARE NEEDED TO BUILD A BIG BOMBER


You can do
ALCOA
YOU CAN DESIGN ALMOST
ANY SHAPE IN
ALCOA
Aluminum
EXTRUSIONS

Materials & Methods
AUGUST 1950

Metal Parts with High Accuracy and Finish Produced by New Casting Process

by B. N. AMES, S. B. DONNER, and N. A. KAHN, Material Laboratory, New York Naval Shipyard

Here is one of the first published reports objectively appraising the characteristics and properties of castings produced by the "C" process and, therefore, provides the engineer with a clear picture of the method and its possibilities.

• IN THE PAST DECADE engineers and designers have exhibited interest in a number of founding techniques which, coupled with a high degree of productivity at a reasonable manufacturing cost, gave promise of obtaining a casting product requiring a minimum of cleaning and machining operations. Some of these, like the plaster molding technique and the several refinements of the "lost wax" investment casting method, have found a practical, if limited, application in many areas of industrial founding.

Recently, a great deal of interest has been expressed in this country in a relatively new molding process popularly referred to as the Croning, or "C" process. The process makes use of thermosetting phenolic plastics as sand binders, and is suitable for the production of castings in aluminum, brass, bronze and some ferrous alloys to close dimensional tolerances and with good surface finish. Other possible advantages claimed for the process include: (1) productivity compares favorably with sand casting practice; (2) thin sections (down to 0.010 in.) can be cast; (3) machining on the castings is reduced and, in some cases, eliminated; (4) cleaning is considerably reduced and shot blasting is frequently eliminated; and (5) saving of metal in casting results in higher yield of metal.

The process was developed in Germany by Johannes Croning, and during the war was used there for the production of fittings cast in light metals and ferrous alloys and for hand grenade cores.

Unfortunately, until recently the technical and operating details of the "C" casting process have been shrouded in a veil of secrecy so that the average engineer and foundryman has not had a clear concept of the method and its possibilities. Hence, this article will briefly describe the process and discuss the characteristics and properties of castings produced by it at the laboratory with which the authors are associated.

Basically, the process utilizes molds made of a dry mixture of silica sand and ~~finally~~ powdered phenolformaldehyde resins. This mixture is poured against a hot metal pattern and held there a few seconds. The resinous binder material softens under the heat of the pattern and, by virtue of its flow characteristics, causes the resin-sand mixture to adjust itself closely to the outline of the pattern, building up a uniform coating about ⅛ to ¼ in. thick. The pattern plate and the adhering coating is then baked for 1 to 3 min., depending on the resin employed, at about 550 to 600 F, after which the finished mold is stripped from the pattern with the aid of knockout pins. The resulting mold is a thin, even, insoluble shell of good strength and rigidity.

To make a casting, two such mold halves are clamped together and bedded in steel shot for support during pouring. Molds are poured off in the usual manner. Due to the high permeability of the mold material, gases developed during pouring pass readily through the mold walls.

Molds and cores made by this method are readily removed from the casting and little or no burning-in of sand is experienced. Only a little

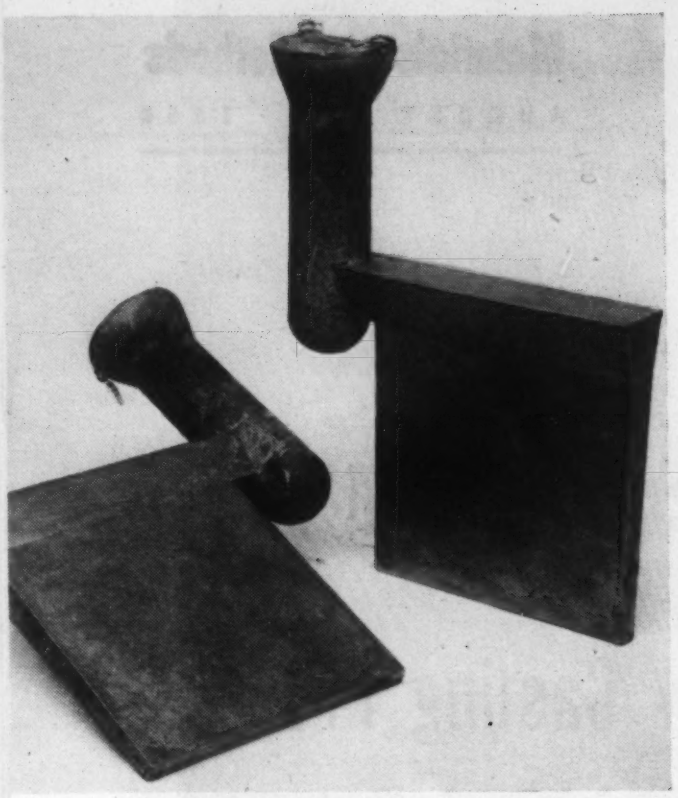


Fig. 1—Typical plate castings of 356 aluminum alloy as-cast, showing excellent surface finish.

cleaning and no shotblasting of the casting is required after removal from the mold.

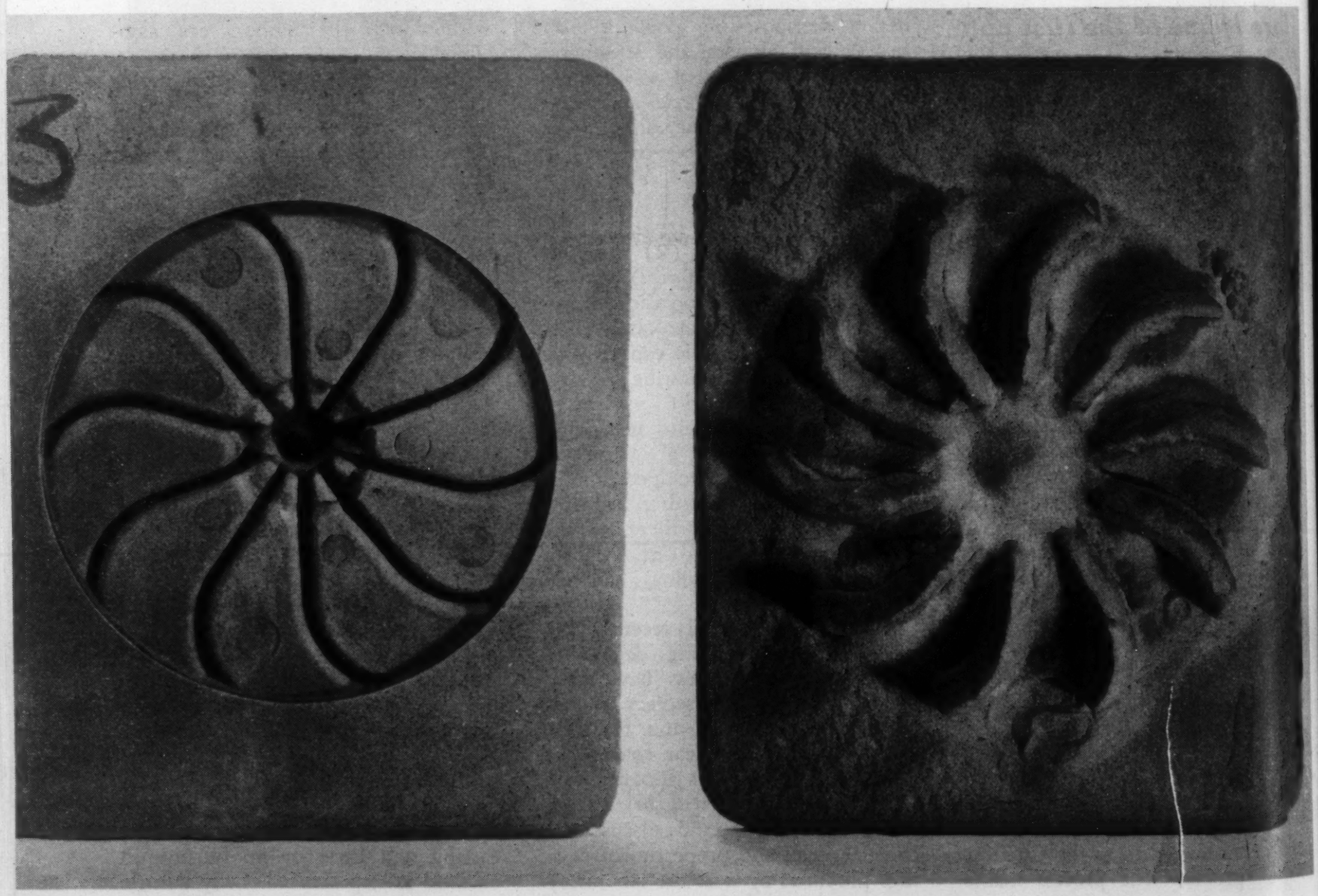
Characteristics of Castings

In order to investigate the casting process and to evaluate the castings thus produced, a number of flat test plates of aluminum alloys were cast. X-ray examination of these plate castings indicated a comparative quality, from the standpoint of internal soundness, with plate castings made in conventional sand molds. Surface examination of 36 aluminum alloy test plates poured at 1250 to 1280 F showed excellent surface finishes, superior to production sand-cast products, with unusually sharp edges and detail. Linear shrinkage was normal for the alloy employed. Precision measurements taken on 15 plates selected at random showed good dimensional reproducibility in which the maximum spread was 0.007 in. On 14 of these 15 castings, the maximum spread was 0.005 in. Readings made on surfaces of varying smoothness on sample castings with a Brush analyzer yielded values ranging from 65 RMS to 190 RMS. The weight of the test plate and attached runner averaged approximately 3 lbs. Typical plate castings in 356 aluminum alloy, which were poured into plastic bonded molds made with 150 AFS fineness sand, are shown in Fig. 1.

For a preliminary examination of the possibilities of the process for the production of items in any alloy, an impeller type casting was selected. This particular design was chosen because it has the elements of thin sections and vanes, heavy sections and a relatively high draw. In addition, designs of this type may be of interest in the stainless and high temperature casting field.

In the interest of economy, the master pattern was rough cast in bronze, hand finished and vapor blasted, with no special effort to provide for proper draft on the vanes. In spite of the almost razor edges of the vane tips, and the thin (1/10 in.) vane tops, sufficient mold thickness was built up in those areas with-

Fig. 2—A dry mixture of silica sand and phenolformaldehyde resins provides extra smooth molds. Here shown is a drag half for an impeller type casting.



out difficulty. The molds were sharp and clean, and detail was reproduced with high fidelity. A sample drag half is illustrated by Fig. 2, and the assembled mold, with a flat cope and fitted with a gypsum riser, is shown in Fig. 3. On aluminum alloy and bronze castings the gypsum was used to promote feeding of the hub area. On ferrous castings, a sand core was used, together with additions to the riser, of an exothermic feeding compound.

Molds were bedded in shot in the usual manner, and poured off in 356 aluminum, gun metal bronze, gray iron, medium carbon, and stainless type steels. The aluminum and bronze castings ran out to exceptional sharpness and high detail, with surface finishes that were much superior to those obtained by conventional sand practice. These castings with the riser removed weigh about 2 lb. in aluminum and 6½ lb. in bronze.

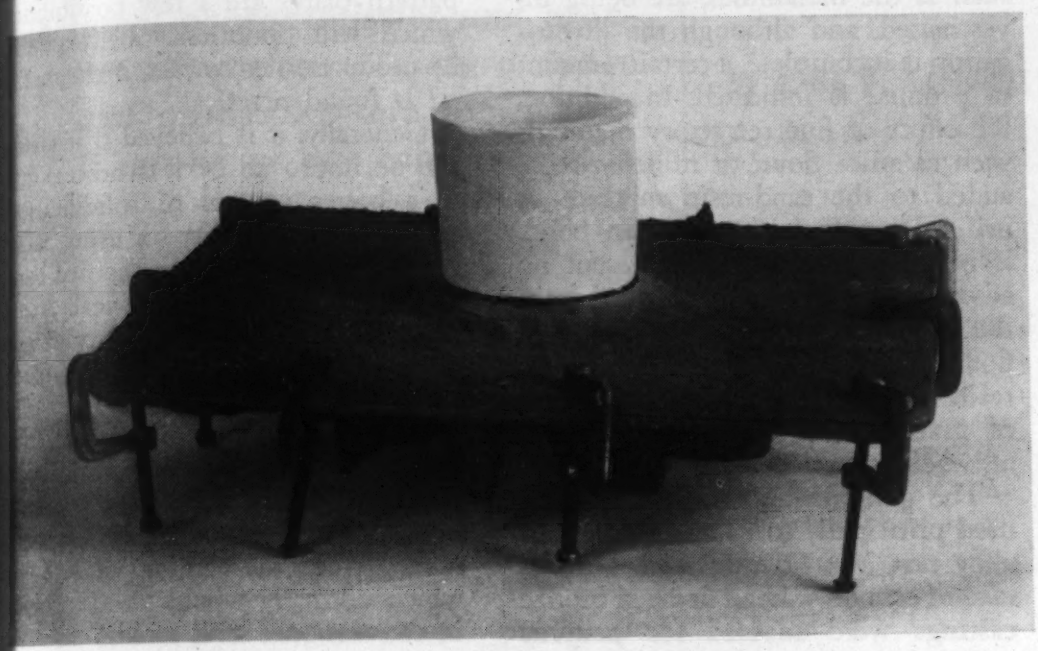


Fig. 3—An assembled impeller mold with gypsum riser.

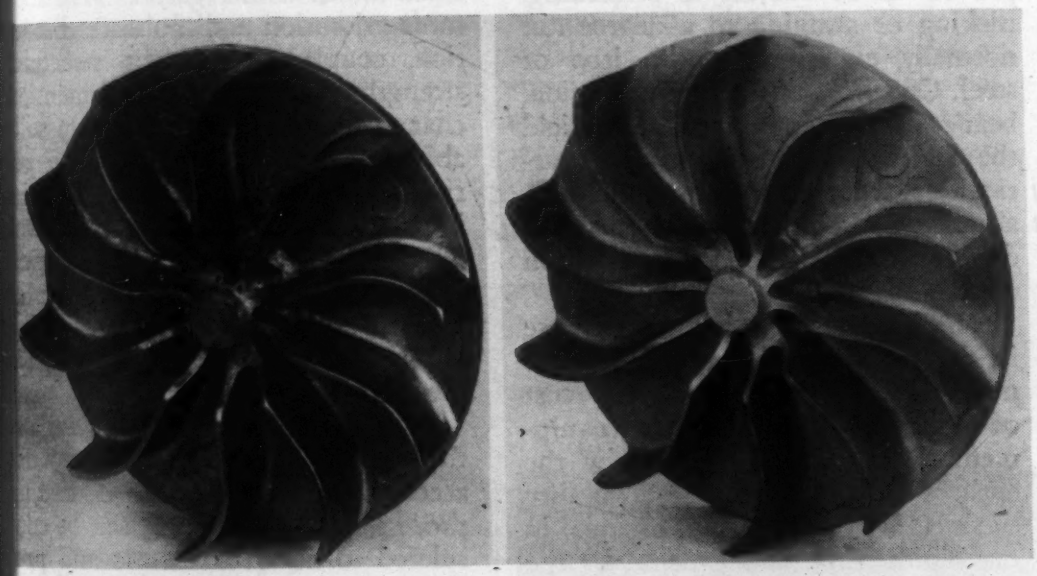
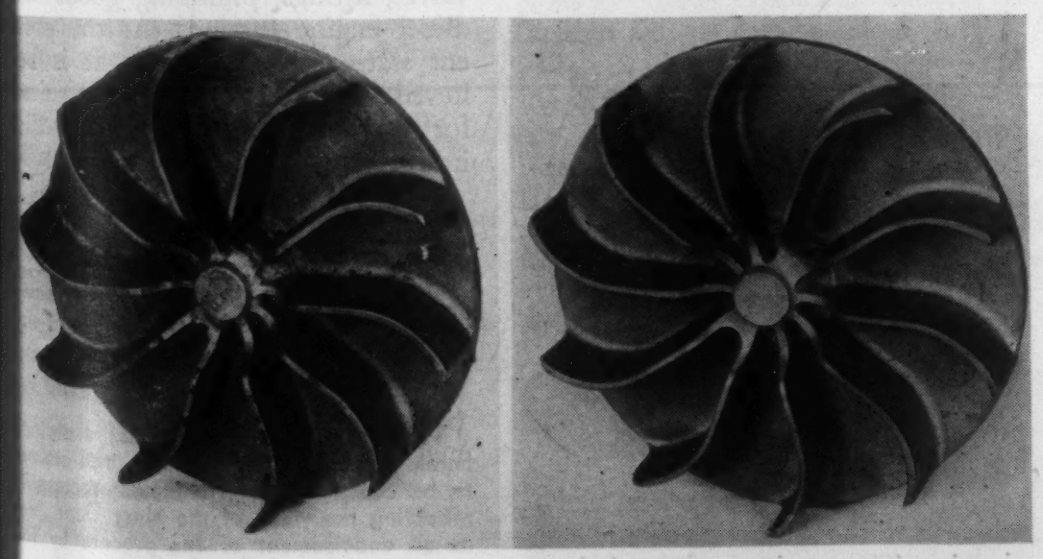


Fig. 4—Impeller castings as-cast (left) and after vapor blasting (right). Top casting is 356 aluminum alloy; bottom casting is Navy gun metal.



Both the aluminum and bronze castings in the larger sizes, and depending on the gating system employed, showed a surface dross condition. In the aluminum alloys it is only a very fine surface film readily removed. In the large bronze castings this condition can be recognized in localized areas after cleaning. X-ray examination of the aluminum impeller wheels and gamma-ray inspection of the bronze impeller wheels indicated freedom from objectionable internal unsoundness. Photographs of castings in 356 aluminum alloy and Navy gun metal in the as-cast and vapor blasted condition are shown in Fig. 4.

Surfaces of these impeller wheels poured in gray iron were highly satisfactory and superior to conventional gray iron surfaces produced in sand molds. However, a slight tendency toward pinholing was evidenced which may be attributed to localized spot concentrations of resin which were not sufficiently cured. Gamma-ray inspection of these gray iron impeller wheels poured with a sand core for the riser indicated freedom from objectionable unsoundness.

The mild carbon steel and stainless steel castings, however, showed a shrinkage area in the hub section. The knife edges on the vanes did not "run," and the surfaces, while comparable with sand castings, did not indicate any unusual advantages from the standpoint of surface finish, for this process, in these alloys at the current state of development.

Another typical casting currently being investigated for manufacture by this process, and which is fairly representative of items in the bronze valve field, is a simple by-pass casting. A sample casting poured in gun metal bronze at 2100 F from these thin shelled molds is shown in Fig. 5. Gamma-ray inspection indicated freedom from internal gas porosity and shrinkage with the gating system employed.

For the investigation of the metallurgical characteristics of the tin bronze alloys as affected by plastic bonded shell molds, a master pattern plate is being utilized. The effect of variations in shell thickness, pouring temperature and grade of steel shot on the mechanical and physical properties of the bronze alloy is being investigated. In addition, wedge castings are being produced in order to study, by X-ray examination, the effect of the above variables on in-

Fig. 5—This bronze by-pass casting is typical of those made by the "C" process.

ternal unsoundness and the extent of the chilled skin formation, if any. The same variables, and their effect on the physical properties of a heat treatable aluminum alloy, are also being studied.

Some Process Details

A number of phenolformaldehyde base resins of both one-step and two-step types have been investigated for their mold making and casting properties. To date, in the opinion of the authors, the most satisfactory phenolformaldehyde resins have been two single step types with moderate flow characteristics. One of the two has an anti-sintering agent added which appears to prolong storage life.

The words "moderate flow" are used in a relative sense since it appears that the plastics manufacturers perform flow tests in varying fashions. In this regard many of the resin manufacturers are conducting research in an effort to produce a resin material which will be "tailor-made" for this process. It is the opinion of the authors that the flow characteristics and melting range of the resins employed are two important properties which must be defined and controlled.

Both low and high flow resins yielded casting surfaces inferior to the resins with moderate flow characteristics. Molds with a high surface glaze indicative of high resin concentration on the hot face, and which appeared exceptionally smooth, did not yield the ultimate in surface finish of the casting produced. This may possibly be due to rapid decomposition of the high resin content at the mold surface, which causes slight metal penetration. At any rate, it may not be far afield to assume that different types of castings will require resin bonding agents with different flow and melting range characteristics in much the same manner that sand mixes and bonding materials will vary today with the alloy and casting design in conventional sand practice.

Other types of thermosetting resins, such as the melamines, are being investigated, and although the investigation is incomplete, a certain amount of promise is indicated. In addition, the effect of fine refractory materials such as silica flour, or milled zircon, added to the sand-resin mixture or utilized singly with the resin bond, is being investigated. At present no advantages appear to be derived from the use of as much as 10% silica flour added to the 150 AFS sand-resin mixture. A study of the effect of grain shape on casting finish is also being carried out.

The pattern and plate materials used principally to date have been of alloy cast iron or mild steel. For the sake of economy, hand finished bronze castings were adapted for patterns on one or two occasions, but these proved to be subject to scratching, nicking or swaging to a degree not normally experienced with iron or steel. Cast iron of the low expansion, heat-resisting type appeared to yield the best overall performance, particularly from the standpoint of resistance to sticking, which may be due to its high graphite population on the surface.

The largest single item of expense in the founding of a casting by this method is, without doubt, the cost of manufacturing the pattern equipment. Work is being done by the authors to investigate the possibility of securing appreciable savings in machining time and expense by the use of easily worked materials suitable for the master pattern plate at elevated temperatures.

The mold release agents which have yielded the best results are silicone jellies (15% by weight) in an ethyl methyl ketone, naphtha or carbon tetrachloride solution and applied as a spray. The number of free draws obtainable from each application will vary with the solution strength and spraying technique. With the technique employed in this investigation, four to five strippings are safely made. The mold release properties of a number of agents for use in this process have been tried and they include the stearates, molysulfides and the synthetic polyethylene glycols. The polytetrafluorethylene compounds show promise and should definitely be considered as a possible mold release agent.

Favorable opportunities exist for a complete mechanization of the molding system on high production runs. Molding machines, conveyorized furnaces, infrared heating, dielectric heating, mechanical stripping and heating elements in the master pattern plates are a few possibilities which will doubtlessly be explored by production engineers, if the method is found practical.

Generally, it is believed that yields can be improved by this process due to a better control of solidification trends and the facility for using backing materials of known thermal conductivities in certain critical areas. Due to the high permeability of the thin shell molds and backing material, the gases generated from the decomposing organic binder are adequately vented with very little back pressure. This, coupled with low frictional losses due to the smooth mold face, permits the running of sections which normally would be a problem in conventional sand molds.

The apparent stability of the finished molds with regard to resistance to deterioration and moisture absorption, coupled with their structural strength and lack of dimension change, make them particularly suitable for storage over indefinite periods. Consequently, it may not be impractical to consider the storage of large quantities of molds for critical casting work, or the shipment of molds between plants, thus reducing duplication of master pattern equipment.

It is the opinion of the authors that, in general, based on the work accomplished to date, the "C" casting process, properly applied, can be considered to be an economic and productive molding medium on long runs or a repetitive class of work, such as valves, fittings, plumbing goods and diesel engine castings. At the present state of development, it is believed that the process is best suited for the nonferrous alloys and cast iron.

References

FIAT Final Report No. 1168, The "C" Process, William W. McCulloch, U. S. Government Office of Technical Services.

Translation of a Report on the "C" Process by Professor Piwowarsky, *Foundry Trade Journal*, Feb. 19, 1948, p. 181.

The opinions or assertions contained herein are those of the authors, and are not to be construed as official, as necessarily reflecting the views of the Navy Dept., nor as an endorsement of the process by the Navy Dept.

Engineering Properties of Felt Make It Useful Material for Industry

This comprehensive survey of the functional characteristics and properties of various standard types and grades of felt shows that it is one of our most versatile engineering materials.

by JOHN B. CAMPBELL, Associate Editor, Materials & Methods

EVEN THOUGH FELT is not a structural material, there can be little doubt that it is one of the most versatile engineering materials we have at our disposal. A comprehensive list of the functional uses of felt would include its applications in polishing and grinding, clutches and brakes, shock absorbing, vibration isolation, spacing, padding, cushioning, packaging, sound absorption, thermal insulation, sealing, wicking, and filtration of liquids and vapors.

In this article, however, no attempt will be made to discuss in detail the myriad uses of felt. Instead, this article will be confined to the general characteristics of felt and the physical and chemical properties of the various types and grades of standard felts. With this as background, a later article will be devoted to the applications and selection of felts.

What Is Felt?

Technically, felt is "a fabric built up by the interlocking of fibers by a suitable combination of mechanical work, chemical action, moisture and heat, without spinning, weaving or knitting. It may consist of one or more classes of fibers—wool, reprocessed wool, and/or reused wool—with or without admixture with animal, vegetable and synthetic fibers."

This is the official definition drafted by The Felt Association, and it corresponds closely with that adopted by the Society of Automotive Engineers. Felt as defined here is commonly referred to as "wool felt" and does not include punched, synthetically bonded, stitched or quilted paper or other materials of felt-like appearance which are products of entirely different construction.

There are many varieties of virgin wool, but only the fleece of the sheep or lamb is used in mechanical felts. Even among these fibers there is a great deal of variety, as they are grown in many different parts of the world. The highest grade wool felts are composed exclusively of specially selected stocks of top-quality virgin wools. The felting property of wool is so effective, however, that it is possible to incorporate as much as 80% of non-felting fibers in a felted material, the wool acting as a binder or structural framework. Examples of such blended stocks are filter felts, which incorporate a rather high percentage of cotton filler, and felts used for sound deadening and thermal insulation of airplane cabins, in which weight reduction is secured by including a large proportion of kapok.

Felt is distinctive among textiles, as it is the only one that can be processed to a density equivalent to that of hard wood without the aid of binders or stiffening agents of any kind. On the other hand, felt can also be used for packing and sound deadening, which require a soft material. Actually, because its physical properties can be adjusted and controlled within a wide range, felt can be used to satisfy a number of apparently conflicting requirements. The variable factor is density, commonly specified as ounces or pounds per square yard for a given thickness. Hardness and elasticity, the other significant properties of felt, are directly related to its density.

It is clear that, the closer the fibers,

Interlocking fibers in wool felt are shown clearly at 75 magnifications. Oval spots are particles of oil entrapped by the material. (Courtesy The Felt Assn.)

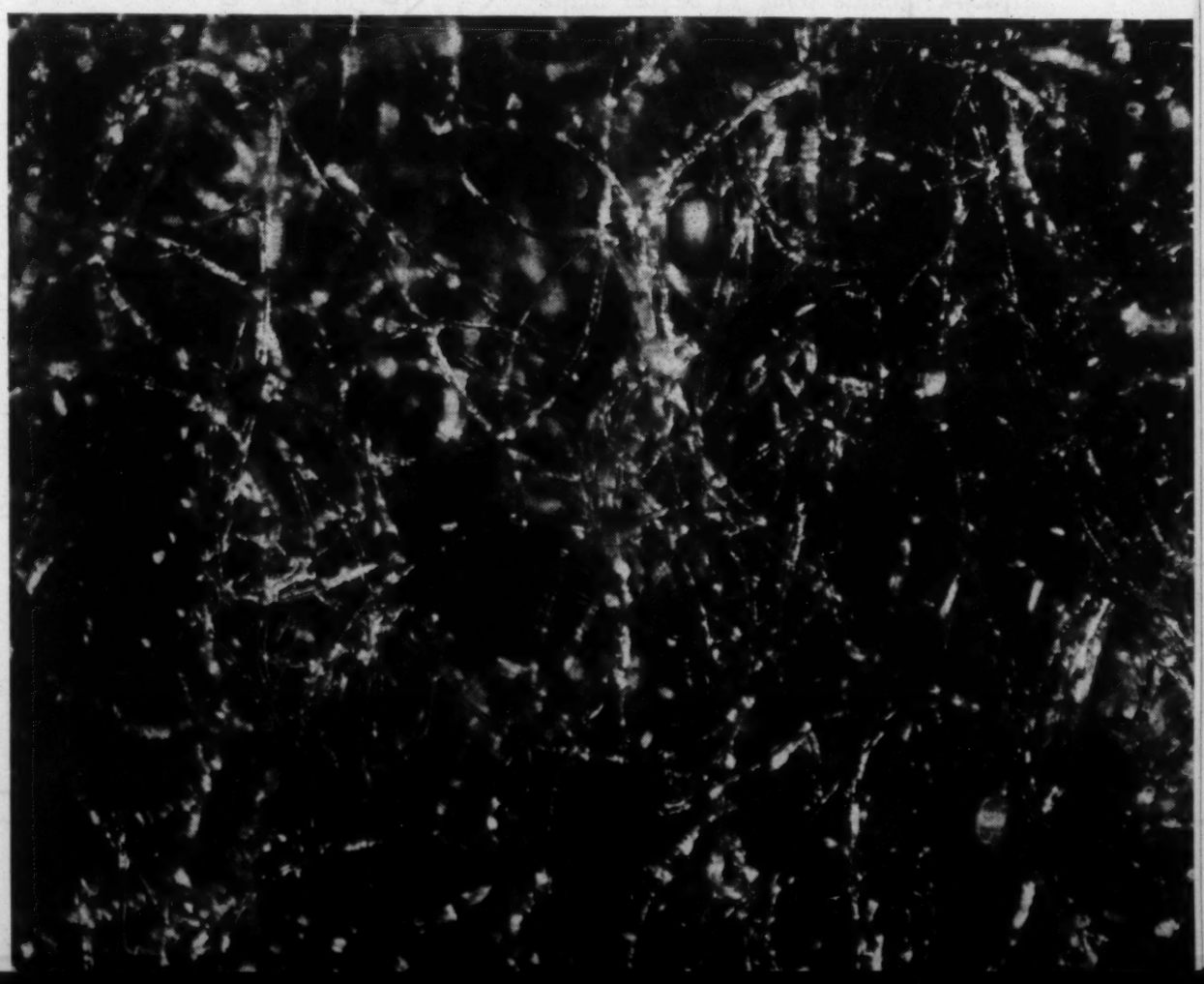


Table 1—Mechanical Roll Felts

Trade Designation	Back Check				Extra Firm Pad			Firm Pad					Soft Pad	Ball Bearing Felt		Lining
Felt Assn. S.A.E.	18R1 —	16R1 F-1	16R2 F-2	16R3 F-3	12R1 F-5	12R2 F-6	12R3 F-7	9R1 F-10	9R2 F-11	9R3 F-12	9R4 F-13	9R5 F-15	8R5 F-26	16R1X F-50	16R3X F-51	12R3X F-55
Chemical Composition:																
Actual Wool Content (Min.), %	95	95	95	90	95	92	80	95	92	85	75	55	45	95	92	75
Carbon Tetrachloride-Soluble Matter (Max.), %	2.5	2.5	2.5	2.5	2.5	2.5	3.0	2.5	3.0	4.0	4.0	4.0	8.0	2.5	2.5	4.0
Water-Soluble Matter (Max.), %	2.5	2.5	2.5	3.0	2.5	2.5	4.0	2.5	2.5	2.5	4.0	5.0	6.0	2.5	2.5	4.0
Combined Carbon Tetrachloride- and Water-Soluble Matter (Max.), %	3.0	3.0	4.0	4.5	3.0	4.5	7.0	3.0	4.5	6.5	8.0	9.0	14.0	3.0	4.5	8.0
Ash (Max.), %	1.5	1.5	2.0	2.5	2.0	2.5	3.0	2.5	3.0	3.5	3.5	4.0	5.0	1.5	2.5	3.0
Physical Properties:																
Breaking Strength (Min.), Psi.	600	500	500	400	400	275	250	225	200	100	75	75	—	500	300	200
Splitting Resistance (Min.), Lb./2-In. Width	35	33	28	22	18	16	12	8	6	3	2	2	—	Not determined for thin grades		
Color	White	White	Any except black or grey	Grey	White	Grey	Grey	White	Grey	Grey	Grey	Grey	Grey	White	Grey	Grey or black
Sizes and Weights:																
Available Thicknesses, In.	⅛, 3/16, ¼, 5/16, ⅜, ½	⅛, 3/16, ¼, ⅜, ½, ⅝, ¾, ⅞, 1											⅛, ¼, ⅜, ½, ¾, 1	3/64, 1/16, 5/64, 3/32		1/16, 3/32
[1]Approx. Thickness Tolerance, ±%	10-4	10-3	10-3	10-3	11-4	11-4	11-4	16-6	16-6	16-6	16-6	16-6	32-12	15-7	15-7	11-7
Nominal Weight, Lb./Sq. Yd.	[2]2.25	[2]2.0	[2]2.0	[2]1.95	[2]1.53	[2]1.53	[2]1.53	[2]1.06	[2]1.06	[2]1.06	[2]1.06	[2]1.06	[2]0.90	0.750 (3/64) 0.975 (1/16) 1.200 (5/64) 1.425 (3/32)		0.750 (1/16) 1.125 (3/32)
Approx. Weight Tolerance, ±%	4.0	5.0	5.0	7.5	5.0	5.0	5.0	7.5	7.5	7.5	7.5	7.5	10.0	[3]0.038	[3]0.038	[3]0.038
Standard Width, In.	60	60	60	60	60	60 or 72	72	72	72	72	72	72	72	60 or 72	60 or 72	60 or 72
Recommended Uses	Oil retention in installations where felt is not compressed. Feeding low viscosity or light oil. Where unusual strength and hardness required. Washers, bushings, wicks, door bumpers, polishing blocks and parts where wear and resistance to abrasion required. S.A.E. F-2 and F-3 used where felt of slightly lower quality is satisfactory.				Dust shields, wipers, grease retainer washers, wicks and applications where resilient felt is required.			Grease and oil retention where felt is confined and compressed in assembly. Also dust shields under less severe operating conditions where F-5, F-6 and F-7 are not required.			Sound deadening chassis strips, spacers, dust shields, pedal pads, dash liners. Mechanical purposes where abrasion and wear are not important factors.		Packing or cladding when held in place between other materials. Not suitable for mechanical purposes.	Ball and roller bearing oil retainer washers, small dust-excluding washers. Also mechanical purposes where accurate, thin, smooth high-grade felt required.	Same general uses as F-50 where tolerances and length of life not as important. Also thin cut parts such as gaskets and liners.	Anti-squeak strips. Lining when cemented to fiber board or metal panels.

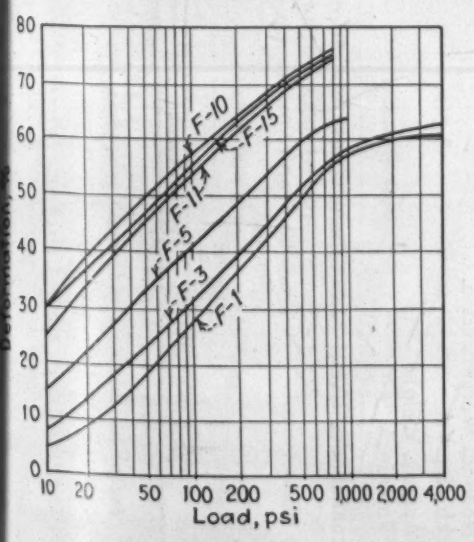
...e greater the quantity of wool pres-...t per unit volume. Hence, the ...reater the specific weight, the greater ... the strength and rigidity of the ...aterial. It is not unnatural, then, ...hat weight should be the principal ...sis for selection of mechanical felts.

The usefulness of felt in most ...echanical applications can be at-...ributed to three general character-...ics—permanence, uniformity and ...orkability. Wool felt does not "age" ...emically, is unaffected by ultra-...olet radiation, ozone and weak re-...gents, and is unchanged by tempera-...re variations in a range from —60 ... +212 F. Since its construction is ...e same throughout, felt wears uni-...rmly without change in rubbing ...aracteristics and never becomes ...readbare. Felt does not mushroom ... flow when compressed, nor does ... ravel or fray when cut; therefore, ...lt parts can be cut to close dimen-...onal tolerances. The firmer felts can ...e turned and carved, and undercut ...ontours can be economically pro-...uced by laminating die-cut sections.

Felt is readily adaptable to adhe-...ve bonding with all types of ma-...rials, including metals, glass, wood, ...ather, fabrics, rubber and plastics. ...ond strengths equal to or greater ...an the strength of the felt can usu-...lly be obtained. Direct combination, ...y tack, pressure-sensitive and heat-...nsitive adhesives can be used, de-...nding upon the particular require-...ents of the job and the material. ...dhesives most commonly used with ...lt are solvent or aqueous base com-...ounds of natural rubber, reclaimed ...ubber, Neoprene or Hycar. These ...e available with or without resin ...odification. For special applications, ...atural gums, glues and caseins are ...ften used, as well as heat-sensitive vinyl and gutta percha sheet laminas.

In addition to adhesive bonding, felt can also be joined to other materials by riveting or by wire stitching.

Graph indicates the amount of deformation caused by various compressive loads. Here, deformation is percentage decrease in original thickness 1 min. after application of load.



Types and Grades

Mechanical felts can be classified in two chief categories, "roll" and "sheet." Characteristics and uses of the standard felts in each category are listed in Tables 1 and 2.

Roll felts differ from sheet felts in density range, dimensional range and in structure. Standard mechanical roll felts are fabricated in a density range from 7 lb. per sq. yd. per in. of thickness for soft pad to 16 lb. per sq. yd. per in. of thickness for back check. Sheet felt densities run from 12 for the soft 12S grades up to 32 for the 32S or "rock-hard" grades. The hardest felts, then, are manufactured in sheet form.

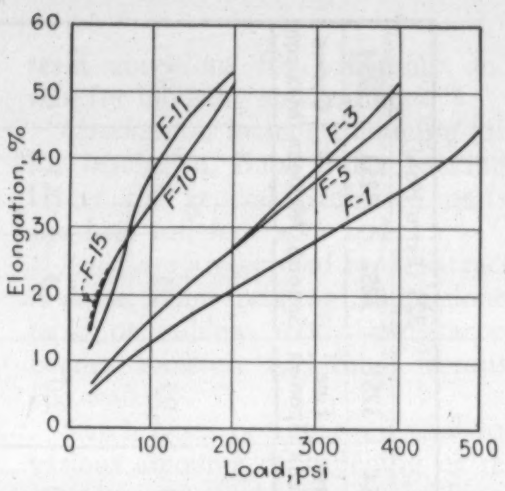
Roll felts are generally fabricated in pieces 40 yd. long and 60 to 72 in. wide, and range in thickness from 1/16 to 1 in. Sheet felts are produced in 36- by 36-in. pieces in a standard thickness range of ¼ to 3 in.

The structural dissimilarities result from differences in the manufacturing process. In the manufacture of roll felts, the carded fibers are piled in batts with alternate webs crisscrossed diagonally to produce transverse strength, whereas in sheet felts the alternate webs are oriented at right angles. This not only produces uniform strength, but in felt "bobs" or turned wheels and special shapes used in grinding, assures a more uniform radial distribution of the tough fiber ends, which do most of the work.

For a felt of a given type and density, the quality is determined by the assortment of fibers, or the "mix." In other words, the quality distinction in felt depends basically upon the grading and blending of the constituent wools which have widely varying characteristics. Thus, the top-quality roll felts are F-1, F-3, F-5, F-10 and F-50, which have the highest chemical requirements. Similarly, the highest quality sheet felts are 12-S-1, 16-S-1, 20-S-1, 26-S-1 and 32-S-1. Non-felting fibers—animal, vegetable and synthetic—can also be used to develop certain desirable properties in felts, but these special-purpose grades have not all been standardized.

Felt Properties

A glance at Tables 1 and 2 is enough to show that the properties used in specifying felts differ widely



Elongation of representative mechanical felts under non-destructive tensile loads is shown here.

from those used for metals or plastics. In fact, the original quality requirements for felt were simply an adaptation of test controls used for textiles in general. The requirements have been expanded as felt has increased in engineering importance. Since the significance of these specification properties is often misconstrued, a brief explanation of each may be helpful.

Wool content indicates the percentage of wool by chemical analysis but does not differentiate between virgin wool, reprocessed wool and reused wool. It is exclusive of traces of other fibers and impurities present in the wool used in fabricating the various types of felt.

Limits on carbon tetrachloride- and water-soluble matter have been set primarily to prevent the manufacturer from weighting his product by adding or leaving in it excessive amounts of oil, grease, soap, sizing, stiffening, dust or dirt. Generally, a small excess of such soluble matter is not important. Compounds used in false weighting of felt can also be detected by the ash test, as they show up as a residue when the fibers are burned.

The breaking strength requirement is traditional for textiles. Since felt is seldom used where it is subjected to a stretching action, a further strength requirement has been added —namely, splitting resistance. In this test, the felt is sliced in the center and the force needed to finish pulling it apart is measured. For felts less than 3/16 in. thick, however, breaking strength only is recommended as an indicative test.

Tests for various end uses, as opposed to quality control, cannot be discussed in detail because these tests vary with the user and his special requirements. Such tests include

Table 2—Mechanical Sheet Felts

Density	12S (Extra Soft)				16S (Soft)				20S (Medium)				26S (Hard)				32S (Extra Hard)			
Type (Felt Assn.)	12S1	12S2	12S3	12S4	16S1	16S2	16S3	16S4	20S1	20S2	20S3	20S4	26S1	26S2	26S3	26S4	32S1	32S2	32S3	32S4
Trade Designation	Fine Spanish	Spanish	Mexican	Coarse Mexican	Fine Spanish	Spanish	Mexican	Coarse Mexican	Fine Spanish	Spanish	Mexican	Coarse Mexican	Fine Spanish	Spanish	Mexican	Coarse Mexican	Fine Spanish	Spanish	Mexican	Coarse Mexican
Chemical Composition:																				
Actual Wool Content (Min.), %	95	95	95	95	95	95	95	95	95	95	95	95	95	95	95	95	95	95	95	95
Carbon Tetrachloride-Soluble Matter (Max.), %	2.0	2.5	2.5	2.5	2.0	2.5	2.5	2.5	2.0	2.5	2.5	2.5	2.0	2.5	2.5	2.5	2.0	2.5	2.5	2.5
Water Soluble Matter (Max.), %	2.0	2.5	2.5	2.5	2.0	2.5	2.5	2.5	2.0	2.5	2.5	2.5	2.0	2.5	2.5	2.5	2.0	2.5	2.5	2.5
Combined Carbon Tetrachloride- and Water-Soluble Matter (Max.), %	3.0	3.5	3.5	4.0	3.0	3.5	3.5	4.0	3.0	3.5	3.5	4.0	3.0	3.5	3.5	4.0	3.0	3.5	3.5	4.0
Physical Properties:																				
Splitting Resistance (Min.), Lb./2-In. Width	18	16	12	10	32	28	22	20	44	40	36	32	48	46	40	30	50	48	46	40
Water Thickness Swell (Max.), %	20	25	30	30	25	30	35	35	30	40	50	50	40	50	60	60	50	60	70	70
Sizes and Weights:																				
Available Thicknesses, In.	¼, ⅜, ½, ⅝, ¾, ⅞, 1, 1¼, 1½, 1¾, 2, 2½, 3																¼, ⅜, ½, ⅝, ¾, ⅞, 1, 1¼, 1½			
	Sheets of ⅛-in. thickness available on order																			
[1]Approx. Thickness, Tolerance, ±%	8.0-4.5				6.4-3.0				5.6-2.5				4.4-2.0				2.8-1.7			
[2]Nominal Weight, Lb./Sq. Yd.	1.50				2.00				2.50				3.25				4.00			
[1]Approx. Weight Tolerance, ±%	6.7-3.7				7.5-2.7				8.0-2.5				9.2-3.1				12.5-3.8			
Recommended Uses	Absorbent pads, vibration and shock mountings, dampeners. Fine and soft metal polishing, buffs, etc.				Same general uses as 12S grades where slightly denser felt required. Also, oil and fluid wicks, washers, plugs, bushings, channels, bumpers, ink and fluid transfer rolls, and general-purpose polishing blocks.				Mirror and glass polishing, lens polishing, cash carrier heads, bumpers, ink rolls, rubber stamp pads, shoe insoles, scratch wheels, wood polishing, furniture rubbing and punched wicks.				Same general uses as 20S grades where denser felt required. Also, glass tumbler polishing, marble and granite polishing, artificial limbs, furniture casters, shoe and boot soles, block cutters.				Same general uses as 26S grades where denser felt required. Also heavy-duty grinding and polishing wheels.			

Except for thickness and weight tolerances, the data in this table have been adopted for specifications by the Felt Association. Standard tolerances have been condensed to approximate percentage form here in order to provide a clearer picture of the density and dimensional variations in felt.

NOTES: [1] *In all cases, the first percentage tolerance given applies to the material of minimum standard thickness; the second to material of maximum standard thickness. Percentage tolerance decreases as thickness increases.*
[2] *These figures represent nominal weight per each ⅛-in. thickness.*

bursting strength, moisture resistance, mildew resistance, oil absorption, wicking, shrinkage, wash fastness, perspiration and light fastness, and permeability.

As stated previously, many of these properties are related to density. In general, an increase in density is associated with greater abrasion resistance, less oil absorption and higher thermal conductivity. The coefficient of static friction appears to be an exception as it is nearly the same for all felts. Against wood it is about 0.37, glass 0.26, dry metal 0.22 and oiled metal 0.18.

Many uses of felt are derived from its load-bearing characteristics. Felt has a relatively low load capacity in tension, but stretches considerably. The latter characteristic is of advantage where felt can be formed by stretching under tension, or by working between dies, into predetermined and permanent contours.

Because it is manufactured under compression and impact, felt is naturally adapted to compressive and shock loading. Relatively light compression loading in a direction perpendicular to the plane of the piece merely closes up the mesh of the fabric, principally by bending non-horizontal fibers. Unloading permits the bent fibers to recover, tending to restore original thickness. Repeating this cycle, without producing a set, uses the natural elasticity of wool to produce a springlike reaction having definite responsive frequency. It is this characteristic which underlies the padding, cushioning and anti-vibration uses of felt.

For a given thickness, load-deformation and the natural vibration frequency depend upon relative density. The light pad felts, for example, compress rapidly under low loads while, for the same deformations and vibration frequencies, the firm and extra firm pads, back checks and still harder sheet felts require correspondingly heavier loads.

Treated Felts

Special service requirements for felt parts can often be met by impregnations, laminations, proofings, sizing or coatings. In each case a wide range of treatments is available.

Impregnations, for instance, include asphalt for weather sealing; Bakelite for dielectric uses; chromate for sealing; graphite for lubrication; Hycar, natural rubber and Neoprene for packing; sealing and gasketing; paraffin-petrolatum for sealing and lubrication; paraffin-graphite-petrolatum for packing and lubrication; resin emulsions for stiffening; and wax for blocking and sealing.

Laminations include aluminum foil for insulation, Buna S for backing, Hycar for general laminated parts, and lead foil for vapor seals.

Proofings are applied for resistance to flame, flame and fungi, fungi alone, mold or mildew, moths and carpet beetles, moisture and fungi, vermin and water.

Starch bases or Latex are used for various amounts of stiffening or reinforcement. And adhesive backings are produced by coatings of Butvar, gutta-percha or rubber.

Acknowledgment

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American Felt Co.
The Felt Association
The Felters Co.
Western Felt Works

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One of the first mechanical uses for felt is believed to be in the hammers of a piano. (Courtesy The Felt Assn.)

by the Felt Association. Standard tolerances have been condensed to approximate percentage form here in order to provide a clearer picture of the density and dimensional variations in felt.

NOTES: [1] *In all cases, the first percentage tolerance given applies to the material of minimum standard thickness; the second to material of maximum standard thickness. Percentage tolerance decreases as thickness increases.*
[2] *These figures represent nominal weight per each ¼-in. thickness.*

ETHODS

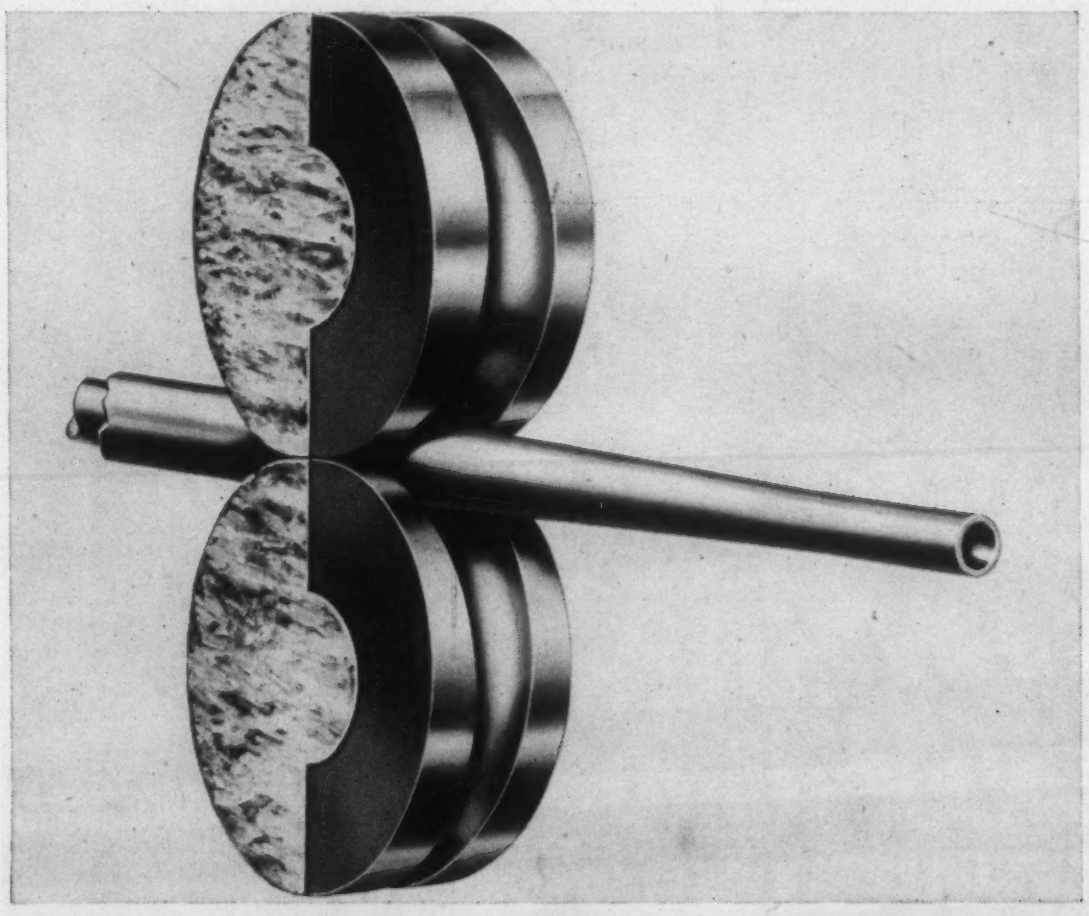
Compression-Formed Steel Tubing Offers Close Tolerances and High Strength Properties

Mechanical tubing cold-sized by compression permits reductions in machining and, therefore, provides opportunities for cost cutting in the fabrication of many parts.

by L. A. KARG, Tube Reducing Corp.

● THE ECONOMIES OF USING tube stock instead of bars or forgings in the manufacture of ring-shaped and similar steel parts are widely recognized. The advantages of cold-drawn mechanical tubing are particularly well known. However, there is another class of tubing—cold-sized by compression—that in many applications provides still greater opportunities for cost cutting. Compared to cold-drawn tubing, compression-formed tubing is produced to closer tolerances, is finer grained, has uniform microstructure, and has a depth of decarburization so shallow as to be negligible. These characteristics permit machining the tubing at higher cutting speeds and feeds with consequent machining cost reductions that can be as high as 50%. In some cases the tolerances are so close as to eliminate machining.

Rockrite tubing is produced by using semi-circular grooved dies that rock back and forth over the tube, compressing the metal of the tube against the mandrel.



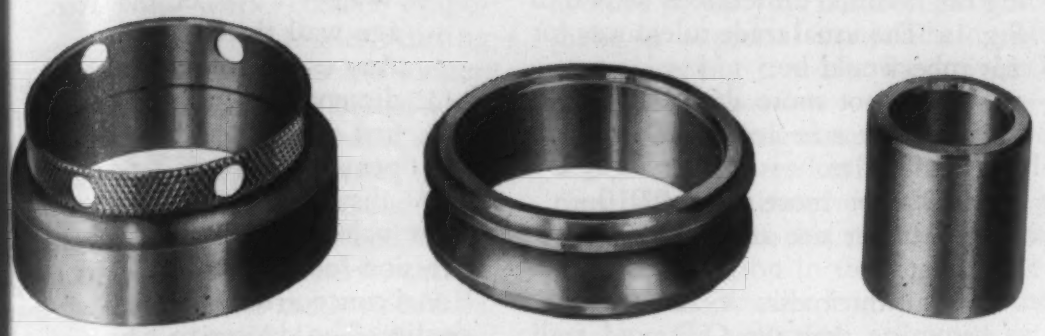
The Compression Forming Process

The method used to make compression formed tubing is known as the Rockrite process. It is a complete departure from the conventional cold-drawing method in which the tube is drawn through a die and over a mandrel in order to reduce the size of the starting tube and improve the accuracy of the outside diameter, inside diameter and wall thickness.

The Rockrite process employs semi-circular, grooved dies which rock back and forth over the tube. This compresses the metal of the tube against a mandrel, which controls the inside diameter. The grooves of the dies are tapered, one end being slightly larger than the outside diameter of the tube to be sized. As the dies roll over the tube, the gradually diminishing cross-section of the grooves results in a compression of the tube walls against a correspondingly tapered mandrel. Thus, the outside diameter, the inside diameter and the wall thickness are reduced and its length is increased.

Suitable mechanisms feed the tube longitudinally through the reducing machine and give the tube a part turn on its axis so as to distribute the work over the entire circumference of the tube. This intermittent rotation or increment feed of the tube, with each work cycle of the dies, results in what might be called circumferential step reduction, since successive areas around the circumference of the tube are worked, one after the other. The step-by-step work around the tube wall acts to reduce any variations in wall thickness, ovality of bore, or eccentricity that might be present in the original tube.

Another significant feature is that the metal in the tube is worked by compression instead of under tension. The amount of work done in a single pass is limited only by the strength of the machine and the wear resistance of the dies. Relatively enormous reductions in size are practicable. Thus, it is feasible to reduce a tube of large size to small diameter, with enough work done on it to secure the



Here are a few of the many close tolerance parts made from compression formed tubing.

desired dimensional tolerances or finish without the need of multiple draw-bench passes and intermediate heat treatments between passes, as is the case in cold drawing.

Available Types, Shapes and Sizes

Rockrite tubing is made in sizes from 7/8 in. up to 6 in. in dia. Metals that the compression process handles include plain carbon steels, alloy steels, stainless and heat resisting steels, bi-metallic combinations, copper and copper alloys, nickel and nickel alloys, beryllium alloys, aluminum and aluminum alloys.

Compression-formed tubing can be sized and shaped over a wide variety of mandrels to secure other-than-round bores or inside contours. Hexagonal, square, triangular bores are common. More complicated splines and internal gears are also easily produced. The contours can be made to such close tolerances that only finish grinding is necessary to get commercially perfect shapes.

Tapered and bi-metal compression-formed tubes can also be produced. Tapered tubing can have constant wall with tapered O.D. and I.D., can have constant I.D. with tapered O.D. and wall, or can have tapered O.D., I.D. and wall. Such tapered tubes can be made in sizes up to 6 in. O.D. at the large end, to practically any size at the small end, with O.D. tapers as low as 0.001 in. per lineal inch, and in lengths up to 124 in. over-all. They can also be upset at the large end.

Bi-metal tubes are produced with either the outer or inner surface of carbon steel and the other surface of copper or a copper alloy. Similar composite tubing can be made of stainless steels, nickel and other metals to meet special requirements of cost, tensile strength, resistance to corrosion or oxidation, or heat transfer.

The cost of compression-sized tubing can vary considerably, and depends on steel analysis, surface finish, and tolerances required. In sizable quantities Rockrite tubing will normally cost up to 10% more than hot finished tube and about the same as cold-drawn tubing. Some of this differential (if not all) in many cases will be offset by the lighter weight of compression-sized tubing, due to its closer tolerances.

It is evident that the closer the tolerances desired, the more the tube must be reduced in size, the more work must be done on it, and the higher will be the cost of dies and mandrels. The first cost of dies is higher than for counterparts in the draw bench, and for extreme accuracy of very large runs of tubing, more than one set of dies may be necessary to compensate for die wear. The cost of Rockrite dies may be prohibitive for short runs of tubing unless accuracy is of paramount importance.

It is, of course, practicable to combine the Rockrite process with cold drawing in order to get some of the inherent advantages of each process. Principal controlling considerations in such a dual process are the quantity of tubing to be produced and the degree of accuracy required in the finished product.

Compression-forming has a definite economic advantage as a preliminary reducing and sizing operation prior to cold drawing. For example, where accurate small tubes are required, say 1/16 in. in dia., the Rockrite process is used to bring the size under 1-in. dia. and thus correct for ovality and varying wall thickness prior to final drawing stages.

The use of both sizing methods is also economically justified when fairly close tolerances are satisfactory and the quantity of tubing made is relatively small. Thus, the Rockrite process can be used to reduce a fairly large quantity of hot-finished tubes to closer tolerances than are standard for cold-drawn tubing, and subsequent draw-bench operations could maintain these tolerances in short runs of tubing of various sizes.

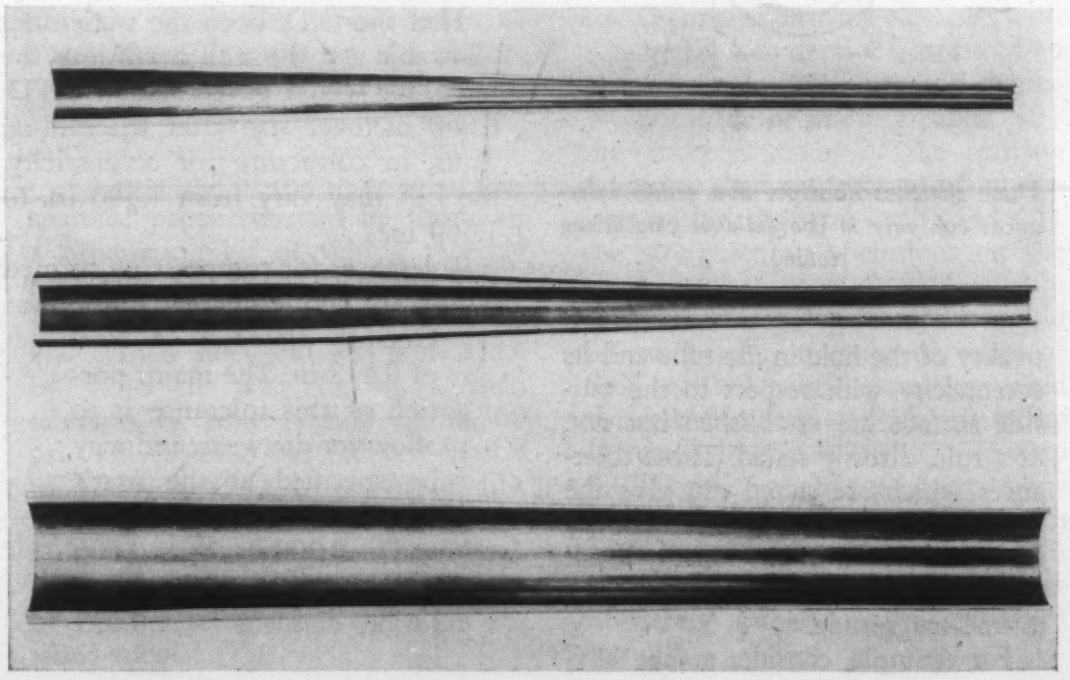
Tolerances

Since cold drawing has been, and still is, the most common method of sizing tubes, it is the basis of the accepted tolerances for variations from nominal dimensions of cold-sized tubing.

However, tolerances for compression-formed tubing are not the same as those for cold-drawn tubing. Compression-formed tubing is sold on a special tolerance guarantee for each order, and the allowable departures from the nominal dimensions and the perfect form of the tube are given in simple terms. This procedure is possible because compression-formed tubing is made on special orders to meet individual requirements.

Cold-drawn tubing is generally made to allowable tolerances in the outside diameter, inside diameter or wall thickness, or any two but not all three dimensions. The permissible

Tapered compression-formed tubes are available with either constant or tapered walls.



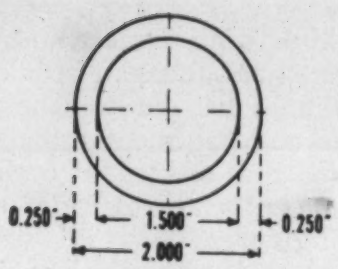


Fig. 1a

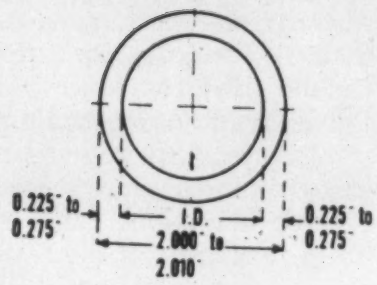


Fig. 1b

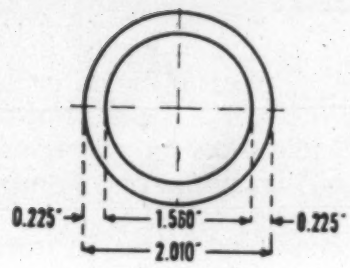


Fig. 1c

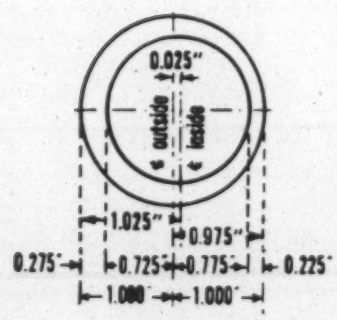


Fig. 1d

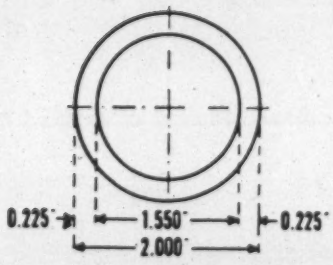


Fig. 1e

These sketches illustrate how widely tolerances can vary in conventional cold-drawn tubing.

ovality of the hole in the tube and its eccentricity with respect to the outside surface are established but not, as a rule, directly stated. Those tolerances which are stated can give the impression of much greater accuracy in the tube than might actually result from variations of the greatest permitted magnitude.

For example, consider a tube having the nominal dimensions shown in Fig. 1a. The usual trade tolerances for this tube would be:

O.D., not more than 0.010 in. over size and 0.000 in. under size.

I.D., not more than 0.010 in. under size and 0.000 in. over size.

Wall thickness, ± 10%

Assuming that the O.D. and wall thickness are specified, the permissible variations, as shown in Fig. 1b, would be:

O.D., from 2.000 to 2.010 in.

Wall thickness, ± 10%, or from 0.225 to 0.275-in.

This is a seemingly accurate tube. However, let's examine the effect of the permissible variations on the I.D. dimension. At some point along the tube the O.D. may be the maximum allowable and the wall thickness may be the minimum allowable. Under these conditions, as shown in Fig. 1c, the I.D. will be 0.060 in. over nominal size.

If the O.D. were the minimum allowable and the wall thickness the maximum allowable, we would find the I.D. to be 0.050 in. under size. Thus, the I.D. could vary from 1.450 to 1.560 in.

At some other point the wall thickness may be the thickest allowable, and diametrically opposite this point the wall may be the thinnest allowable. Then the dimensions will be as in Fig. 1d.

Under these conditions the I.D. will be exactly the nominal size, 1.500 in., but will be off center 0.025 in. If the inside is bored out true to the O.D., the thicker side of the wall will be machined down to 0.225 in. and the finished dimensions will be as in Fig. 1e. The I.D. will then be 0.050 in. over size.

Had the O.D. been the maximum allowable and the wall conditions the same, we would have found the I.D. 0.060 in. over size after machining. Thus, in correcting for eccentricity, the I.D. may vary from 1.500 in. to 1.560 in.

Tolerances for compression-formed tubing are approximately as follows:

Outside diameter—a total of 0.012 in. The major portion of this tolerance is to allow for die wear, and may be specified at the user's convenience as ± 0.012 in. and —0.000 in., or ±0.006 in.

Inside diameter — ±0.005 in.

Wall—±5% of the average wall thickness.

Any two of the above three dimensions may be specified without additional expense.

A distinguishing and frequently most valuable characteristic of compression-formed tubing is its exceptional concentricity and freedom from ovality. The degree to which any eccentricity or ovality of the original tube is corrected will depend mostly upon how much reduction is made in the tube size or wall thickness. In a typical case, an eccentricity of 12½% is reduced to 5%, or a variation in wall thickness of ±12½% of the average wall thickness is reduced to ±5%.

Close dimensional tolerances attainable in compression-formed tubing are most pronounced in the case of small diameter tubes with relatively thick walls. If the I.D. of a cold-drawn tube is ⅝ in. or less and the wall thickness is more than 20% of the O.D., it is difficult, or impracticable, to cold draw the tube over a mandrel. The operation then becomes one of collapsing the tube by drawing it through a die with a resultant loss of control over the finished dimensions. In the compression process control over the sizing operation is the same as in the case of lighter wall tubing.

The effect of close tolerances in heavy-wall tubing can be judged from studying the permissible variations in dimensions of a tube to be machined to 2 in. O.D. and 0.800 in. I.D. This tube, under accepted cold-drawing tolerances and an allowance of 0.020 in. per side for machining, could have an O.D. as large as 2.050 in. The I.D., with similar allowances, would nominally be 0.690 in., and might be as large as 0.760 in. and as small as 0.632 in. In other words, the permissible difference between the maximum and minimum inside diameters is over 0.125 in., or nearly 17% of the greatest allowable I.D. In the case of compression-formed tubing this difference would be 5.27%, or 0.040 in. A cold-drawn tube of this nominal size might have a hole that is eccentric with the outside by as much as 0.083-in. In compression-formed tubing of this nominal size, the eccentricity would not exceed 0.020-in.

The closer tolerances in compression-formed tubing permits economies in machining operations by eliminating heavy, slow and costly drilling, and permitting faster boring or reaming. Temperature of the work is reduced, thereby permitting quick

gaging of the work, coolant evaporates more slowly, higher cutting speeds are possible, tools last longer, work-surface finishes are better. Output of work pieces is increased as the result of higher cutting speeds, use of forming tools is practicable, and operations can often be combined. Tube stock weighs less per lineal foot, making it easier and less costly to handle, magazines can handle longer lengths, and recharging time is reduced, crop losses may be lower, and O.D. or I.D. may require no machining.

Finish and Decarburization

The smooth surfaces of compression-formed tubing are the result of the manner in which the metal is worked. As the dies compress the metal against the mandrel, they tend to iron out small irregularities of the outside and inside surfaces of the metal. The metal flows from high spots into indentations in the same manner as when it is forged or extruded. In addition, a certain amount of burnishing or planishing action takes place.

Decarburization in tubing may or may not be objectionable, depending on the application. When decarburization is objectionable and when it cannot be avoided during the manufacture of a tube, it is eliminated by machining. In such cases the tubing must have sufficient stock in the wall to permit the removal of the decarburized layers. This frequently necessitates the purchase of tubing having a substantially heavier wall than is wanted, to allow for the machining.

In cold-drawn tubing the decarburized layer can be worked down until it is so thin as to be wholly unobjectionable, but this may require several passes through the dies, and these several passes may necessitate intermediate heat treatments which aggravate instead of correct the condition. This aggravation can be avoided by carrying out the heat treatment in a special non-oxidizing atmosphere, but it is not the universal practice to do so.

Any decarburized surface of a tube which is compression reduced is almost always thinned down to such a thin layer as to be negligible. The precise reduction in the depth of decarburization will depend upon the percentage reduction in cross sectional area of the metal in the tube. This reduction is normally the equivalent of that resulting from three to five cold-draw passes, which are sufficient for this purpose. But this number of passes may not be necessary to secure the other results for which cold-drawing is used. In other words, customary and every-day compression reduction in size is as great as that used in cold drawing for the purpose of reducing decarburization, and can even be greater. Furthermore, no intermediate heat treatments are necessary in this reduction of compression-formed tubing, so there is no liability of the tube being decarburized while undergoing treatment for decarburization.

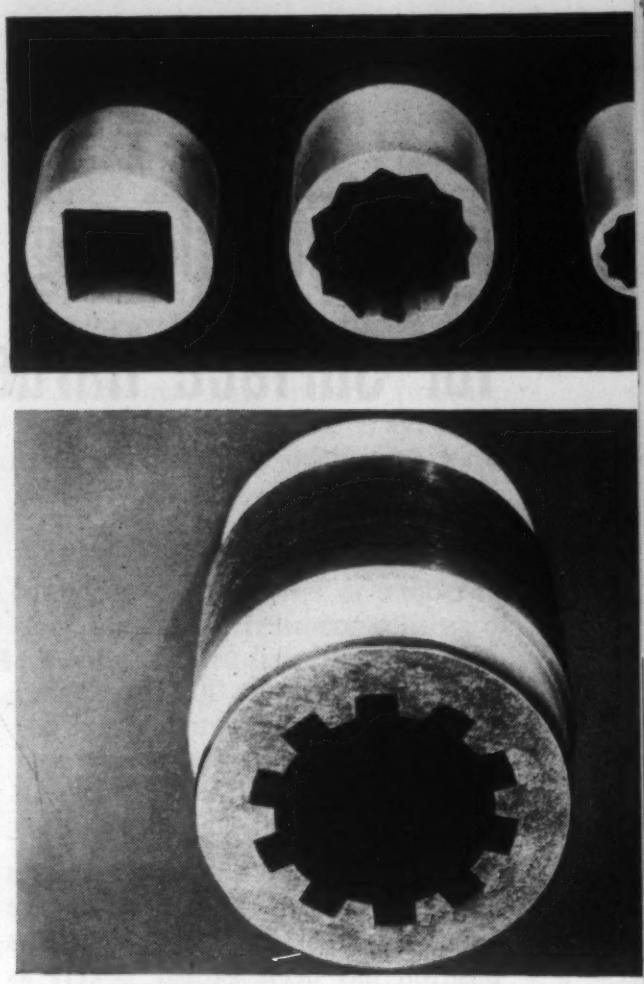
Typical Profilometer Readings on Compression-Formed Tubing

Type of Steel	Profilometer Readings in Microinches, RMS
1015	10-35
X1020	30-55
C1118	25-45
52100	15-55
WD4140	5-12
Cast Stainless Type 304	34-54

Mechanical Properties

Tubing produced by the compression process has better grain structure and higher physicals than cold-drawn tubing. This permits significant savings where tubing is used in the production of ring-shaped or cylindrical parts. In the case of pressure cylinders, the walls can be lighter because mechanical properties of compression-formed tubing are higher. Frequently, the compression process increases physicals of the hot finished starting tube 100 to 150%. Because of the higher mechanical properties, compression-formed tubing is less liable to rupture due to thermal shock during heat treatment, is less liable to burst under pressure of the clamps when being gang sawed, and is less liable to crack when handled and shipped, especially in cold weather.

An example of the increase in mechanical properties can be found in a production lot of tubing recently processed by Tube Reducing Corp. The starting tube was SAE X1020 low carbon steel and was 4 in. O.D. by 5/16 in. wall, having a yield strength of from 41,300 to 58,300 psi. This tubing was reduced in size to 3.226 in. O.D. by 2.870 in. I.D. The final yield strength ranged from 102,900 to 108,800 psi. The following table shows the yield strengths of eight starting tubes and eight finished tubes.



Compression-formed tubing can be produced in a wide variety of inside contours, a few of which are shown here.

Starting Tube, Psi.	Compression Formed Tube, Psi.
58,300	107,400
44,300	108,000
41,300	102,900
41,700	105,000
42,200	106,900
41,400	103,200
45,000	108,800
41,500	104,400

The foregoing figures cannot be used as is for design purposes because it is impossible to control closely the yield strength resulting from the process. There are too many variables with which the manufacturer is forced to contend, including: (1) the degree of anneal of the starting tubes; (2) the grain structure of the starting tubes; (3) the segregation of impurities within the steel itself; and (4) the straightening operations on the starting tube.

For the foregoing reasons it would be much safer to count on tubes of SAE X1020 with a starting yield strength of about 41,000 psi., being increased by the Rockrite process to 80,000 psi. Actually, of course, many of the tubes will have a yield strength in excess of 100,000 psi., but this should be used as an added factor of safety rather than a predicted strength.

Flame Hardening Now Widely Used for Surface Hardening Steels and Irons

by E. F. GREEN, Axelson Manufacturing Co.

Selective heat treatment using high temperature flames has advanced rapidly in recent years and offers a number of advantages that are worthwhile considering.

● FLAME HARDENING has become an accepted standard method of surface hardening steel and iron parts. This position has been gained largely as a result of the many developments in equipment and techniques which have advanced the process to its present state of mechanical refinement.

Briefly, flame hardening involves heating a ferrous metal above the transformation range with a direct high temperature flame, followed by cooling at a selected rate. The process has a number of distinct characteristics and advantages that are worthwhile considering. The method has been frequently compared to a portable heat treating department. Large parts, which are of such a size or shape that furnace hardening would be impractical, are often easily flame hardened.

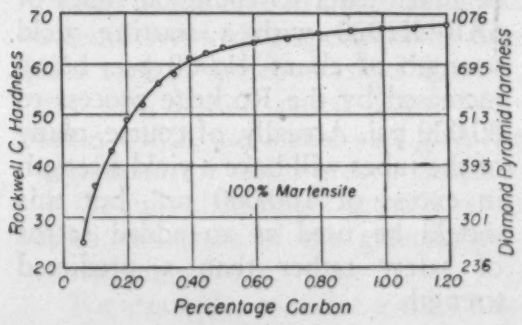
Flame hardening is essentially a selective process, since the hardening is usually restricted to the surface of a part or some localized area. The core underlying a flame hardened surface is unaffected by the heat and hence retains its original desired tensile strength. Also, the gradation of case to core is gradual because the full flame hardened case hardness extends for a depth of approximately ⅔ the indicated depth. This prevents spalling of the case from the core.

It is frequently possible to develop higher surface hardness by flame hardening, than by furnace hardening, and the depth of hardness and hardness pattern are uniform. In some applications a flame hardened carbon steel can be substituted for a furnace hardened alloy steel with an ultimate saving in material cost.

Flame hardening tends to reduce distortion in many designs. In addition, the high speed of this process results in parts being scale-free, thus saving cleaning costs and preventing loss of scaled away metal.

One of the most attractive aspects of the process is the low equipment cost. Simple jobs can be quickly set up with low expenditure for equipment. Flame hardening is also readily adaptable to mass production methods. Once a procedure is set up, it is easily duplicated in quantity production.

Influence of carbon content on the hardness of fully martensitic steel, as quenched.



Materials That Are Flame Hardened

Any type of ferrous material which can be furnace hardened can be flame hardened by following suitable procedures. In carbon and low alloy steels, the carbon content should be over 0.35%, preferably 0.45 to 0.50%. The maximum hardness of the flame hardened surface is primarily dependent on the carbon content and is not increased by the use of alloys. Alloying elements such as nickel, chromium, molybdenum, and others, serve to modify and improve other properties such as corrosion resistance, core strength and wear resistance, and to reduce hardening temperatures.

In the heat treatment of steels, the initial metallurgical structure has a bearing on the finished hardness. The reason for this is that certain microstructures go into solution much faster than others when steels are heated above their transformation temperature. In carbon and low alloy steels a normalized structure is the easiest to harden, while some annealed structures are the most difficult to harden.

Steels and irons which are in an unevenly strained condition before flame hardening may distort during the hardening operation. For minimizing distortion, either a hot rolled or stress relieved condition offers the best results.

Another material which can be flame hardened is the martensitic, or hardenable stainless steel.

Gray iron is particularly adapted to flame hardening. Gray iron which is to be flame hardened should be pearlitic with a combined carbon content of 0.50 to 0.80%. In general, the lower total carbon content gray irons are best for flame hardening. Here again alloy gray irons are not necessary to obtain maximum hardness, but are beneficial in improving the processing and service properties.

Pearlitic malleable irons are often flame hardened, and offer an excellent combination of properties. The presently much-publicized magnesium- or cerium-treated nodular cast iron can also be flame hardened.

Steels and irons are usually heated in the range of 1400 to 1800 F, de-

pending on the material type and condition. It is imperative that materials are not overheated, for inferior case properties will result. Usually there is a tendency to underjudge temperatures because of the light of the flame. Overheated and hardened surfaces are coarse grained, brittle, and of reduced hardness. Overheating can result in excessive distortion, heavy case depth, cracking, and even melting of the work. When it is necessary to finish grind an overheated hardened case, the coarse grained steel is particularly subject to the development of grinding cracks. Correct hardening temperature greatly minimize grinding difficulties.

Proper hardening temperatures and procedures can be checked by examining the hardened structure under the microscope. By making a practice run and suddenly shutting off the flame and quench, a true estimate can be made of the temperature.

Quenching and Stress Relieving

Quenching equipment is influenced by the flame hardening method, material type and desired properties. In the progressive method the after-quench must fully cover the heated surface. Usually a spray quench is employed which is built into the heating tip or which closely follows it. The angle of spray is from 10 deg. to 20 deg. and strikes the work from ½ in. to 1¼ in. in back of the flames when hardening steel or gray iron. It is important that the streams of spray water do not strike the work at too high a velocity and bounce off the heated surface, resulting in inadequate cooling. Alloy steels may require a greater spacing between flames and quench in order to slow down the speed of quenching. Too high a speed of cooling can result in cracking of sensitive steels.

Under certain conditions it may be necessary to employ a fore-quench to prevent heat built up in front of a progressive heating tip and consequent uneven heating. On any appreciable section thickness there is enough unheated material underlying the heated surface that the colder metal acts to assist the surface quench.

Various quenching mediums can be used such as water spray, water immersion, soluble oil and water, quenching oil, and compressed air. The use of any particular quenching medium is governed by the requirements of the grade of steel or iron and the desired properties.

Certain precautions must be observed in quenching operations in order that adequate cooling occurs. An example of these precautions would be the immersion of a spinning gear in a quenching medium. If the gear is rotating at too high a speed, the gear teeth act as impellers and the cooling medium is thrown out of the tooth root, resulting in poor quenching.

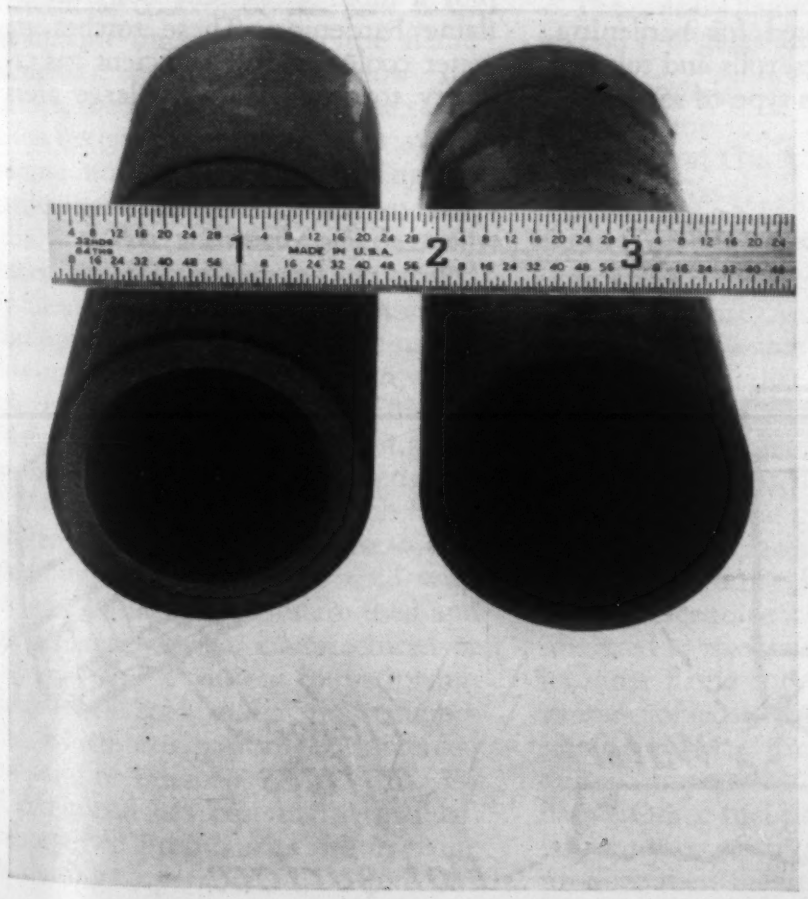
A sufficient supply of quenching fluid must be provided to cool the heated work. The supply line should be of ample size in order that it will not be disturbed from outside demands. On water lines used for spray quenching, it is often desirable to install pressure regulators and surge tanks to maintain uniform pressure. Nonuniform hardening may result from variations in quenching water pressure.

Wherever practicable, the flame hardening operation should be followed by a stress relief or tempering operation. This treatment consists of reheating the hardened part to a temperature of 300 to 400 F. Small parts can be tempered in a furnace, while large parts are often flame heated. The treatment has little effect upon hardness and enhances the case properties by preventing cracking, minimizing distortion, decreases grinding crack susceptibility, and improves toughness.

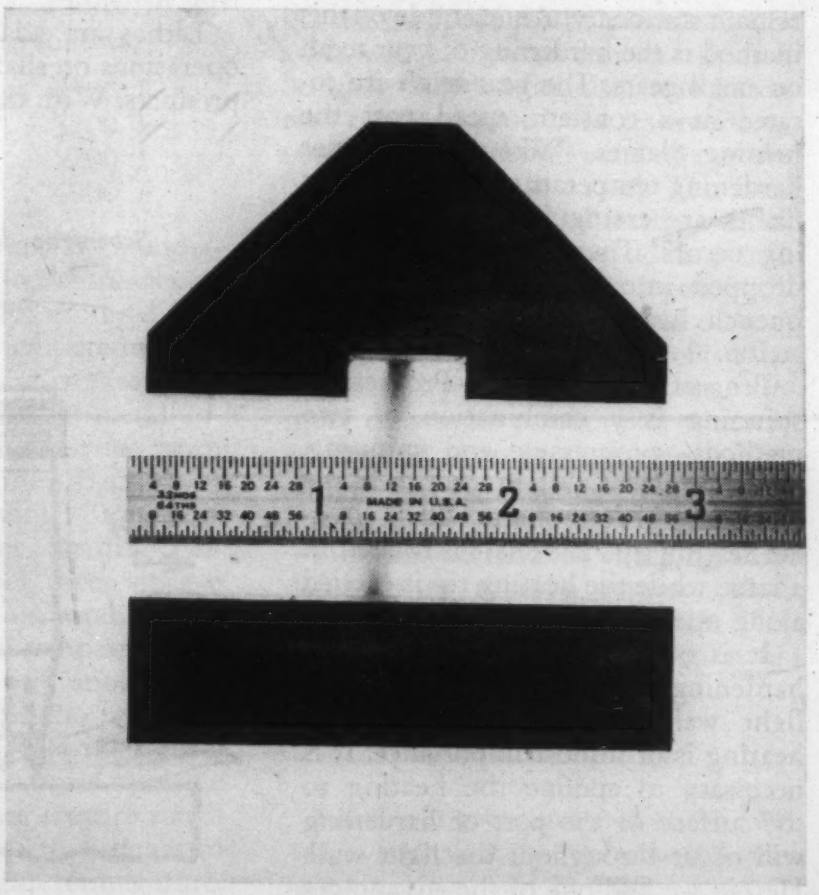
The stress relief also acts to prevent movement or distortion of flame hardened parts after they have been put into service. Another procedure which has been used on flame hardened alloy steel parts to prevent distortion in service is to cold treat at 110 F and temper at 350 F.

Flame hardened parts which are to be electroplated must be tempered to

Right—O. D. flame-hardening on oil well pump plunger; left— I. D. flame-hardening on oil well pump working barrel.



Cross-section of lathe way sections showing contour of flame hardening.



prevent hydrogen embrittlement and cracking of the hardened surface during the plating process. It is also advisable to stress relieve the plated article after plating.

Flame Hardening Methods

Flame hardening procedures can be divided into four different methods, which are as follows: (1) stationary, (2) progressive, (3) spinning, and (4) progressive spinning.

Stationary—The stationary or spot hardening method includes the operation where the heating flames and work are without motion during heating. An example of this would be the hardening of automobile valve stems.

Progressive—The progressive method signifies a relative motion between the heating flames and work. An example of this method is the hardening of machine tool ways. Using this method the heating tip is followed by a quench which is usually a water spray. On large rounds hardened by a series of circumferential paths, a slightly softer zone will occur at the overlap. The same condition prevails when parallel runs are made on wide flats. In the progressive method, traverse speeds may vary from 3 to 12 in. per min., although usual speeds are 4 to 6 in. per min. The heating tips are placed so that the tips of the inner cone are 1/16 in. to 1/8 in. from the heated surface. Vase depths can be as selected from 1/64 in. to 1/4 in.

Spinning—In the spinning method the work spins and the heating flames remain stationary. An example of this method is the hardening of gear teeth on small gears. The gear teeth are rotated at a constant speed past the heating flames. When the proper hardening temperature is reached, the flames are extinguished and quenching occurs. The heated gear can be dropped into a quenching fluid or quench heads can be brought into action.

Progressive Spinning—Progressive spinning is a combination of two methods—progressive and spinning. An example of this procedure is the hardening of long shafts with a circular heating tip. The shaft is rotated in a lathe while the heating tip is carried along on the carriage.

It is of interest to observe when hardening to light case depths on light walled tubing that speed of heating is of utmost importance. It is necessary to confine the heating to the surface of the part or hardening will occur throughout the light wall. Herein we find one of the advantages of the high heating speed of acetylene. Certain jobs such as these have requirements which can be met only by the use of oxyacetylene heating.

Equipment and Fuel

The type of equipment necessary to flame harden any part varies considerably according to the desired hardness pattern and production quantities involved. Setups may vary from the manual use of a welding torch to elaborate flame hardening machines with controls over all variables.

There are many flame hardening applications where the size and quantity do not justify much expenditure for equipment. These parts can be set up for manual operation with excellent results. In general, however, it is advisable to mechanize the process whenever possible in order to eliminate operator variables. When the process is under machine control it is possible to arrive at a proper setup, and then to duplicate the procedure.

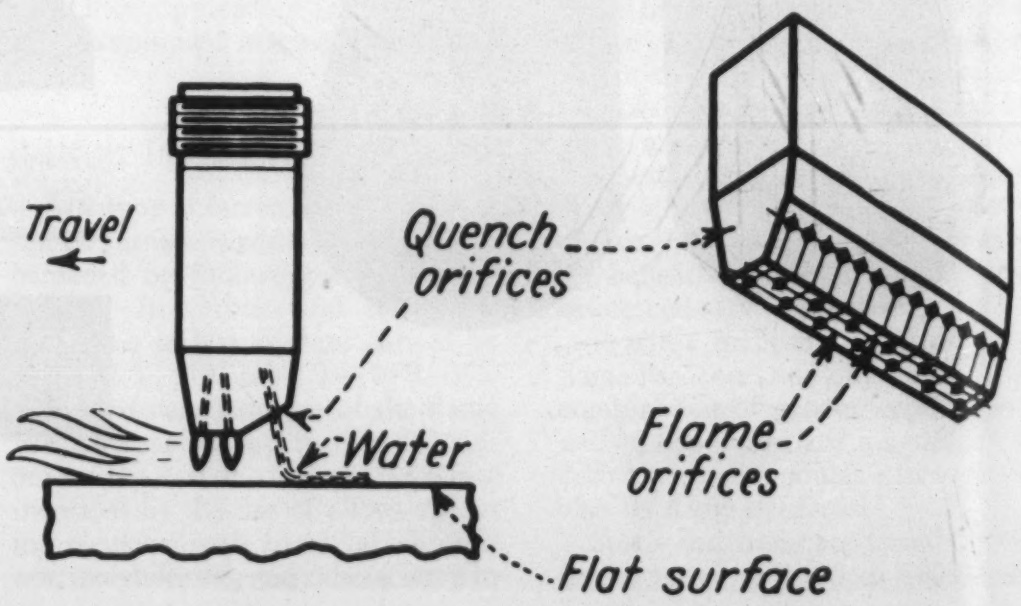
Very often the flame hardening process can be readily adapted to existing machine tools or other equipment in a production shop. On certain types of work, one of the ideal pieces of equipment is an oxyacetylene cutting machine. This type of machine provides the linear motion for the flame hardening torch under accurately controlled and readily adjusted speeds. It is of interest to note that the linear speed of the usual flame hardening operations falls within the range of speeds obtainable with cutting machines.

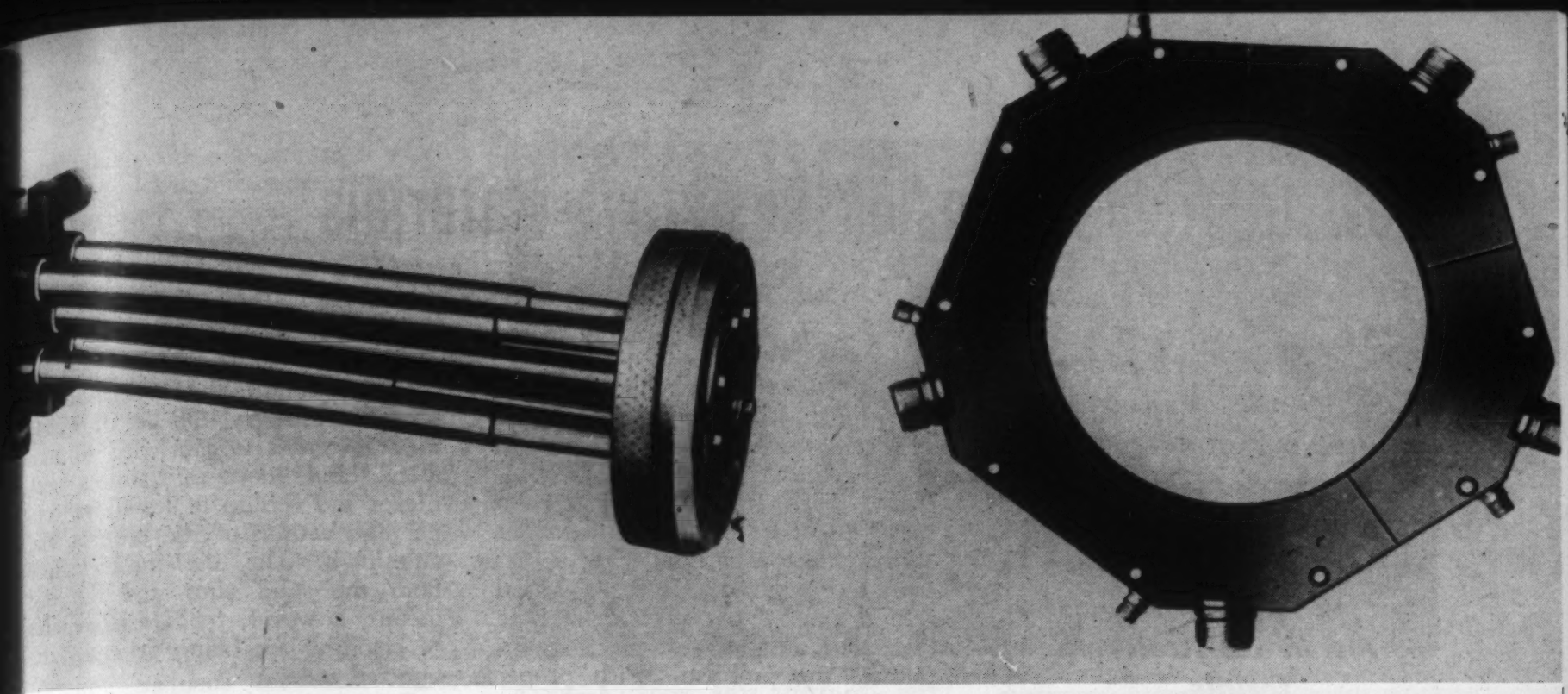
Lathes are adapted for hardening operations on shafts, rolls and tubular products. With this type of setup, the work is mounted and turned between the chuck and tailstock center. The flame hardening torch and tip are mounted on the tool holder on the carriage. Under these conditions the process is under excellent control. Other machine tools which are used are drill presses, planers and boring mills.

In recent years there has appeared on the market a number of flame hardening machines specifically designed for this purpose. These machines control work and torch speeds, and are easily varied to meet varying work requirements. One of the most recent innovations on the machines is the use of an electronic temperature control system. By this means a temperature-sensitive device is optically focussed on the heated work piece during the heating cycle. On progressive flame hardening operations, the electronic temperature control maintains the pre-set temperature by varying the traverse speed of the heating flame. The actual temperature is indicated and recorded on a chart. If the electronic temperature control is used on unit heated work, the device extinguishes the flames when the proper pre-set temperature is attained and actuates a subsequent cycle of work release and quenching.

The heating apparatus is the heart of the flame hardening operation. It is necessary that the equipment be of rugged design and flexible in operation. A simple welding torch can be used for some flame hardening operations. Usually it is advisable to employ a torch specifically designed for flame hardening. These torches are water cooled and of sufficient gas capacity to treat relatively large areas

Schematic drawing showing essential features of flame-hardening process.





On left, a large round; on right, segments of the tip in which each segment is operated as an individual torch.

in one operation. The heating heads or tips used with the torches can be obtained from apparatus manufacturers or be designed and built by the user. The nature of the flame hardened work dictates whether standard or special tips be necessary.

On large work, tips can be made into segments and independently operated from individual torches. Some tips are manufactured to accommodate variable widths or irregular profiles by providing threaded removable type tips in various lengths and with different tip orifices. Plugs can be used to replace individual tips if it is desired to operate only a portion of the tip.

Accurate control of gas flow is of paramount importance in the flame hardening operation. As flow increases, the necessity for precise regulation becomes more critical for maintaining uniformity of hardening. In hardening operations of any magnitude, it is recommended that manifolded gases be used and controlled by means of two-stage regulators. Certain operations can dictate the use of flow-meters in gas lines for an accurate indication of gas flow. This information is useful in duplicating and maintaining uniform heat intensity.

Various fuels are used in the flame hardening operation. The most widely used fuel gas is acetylene used with oxygen. Other fuel gases are used and include natural gas, manufactured or city gas, and a variety of petroleum derivatives sold under trade names but which are basically commercial propane or butane.

Acetylene has certain thermal advantages to promote its use in flame hardening operations. Despite its higher initial price, some of the properties attendant to its use makes the over-all hardening operation more economical than when using other fuel gases.

Acetylene is a type of chemical compound which gives off heat when it decomposes. All other fuel gases absorb heat to complete their decomposition. Acetylene, then, adds heat to that generated by the combustion of its carbon and hydrogen constituents while other fuel gases remove some heat from the carbon hydrogen combustion. It is for this reason that acetylene develops an oxyflame temperature over 1000 F hotter than any other fuel gas.

The ideal flame temperature of several fuel gases are as follows:

Acetylene	6300 F
Propane	5200 F
Natural Gas	5200 F
City Gas	4900 F

The rate of heat transfer by radiation varies with the fourth power of the temperature. Analyzing the different fuel gas flame temperatures, it will be found that the oxyacetylene flame transfers heat to the metal approximately twice as fast as with other oxyfuel gas flames. Because of its additive heat-giving properties, acetylene has greater heating efficiency than other fuel gases since a larger percentage of its total heat is liberated at maximum temperature in its inner flame cone. Still another advantage of acetylene is the relatively small amount of oxygen which is required to produce its most effective flame. Other fuel gases require much larger ratios of oxygen to fuel gas to produce their maximum temperature.

Testing and Inspection

Flame hardened surfaces are customarily tested for hardness to check the quality of the process. Two of the most commonly used instruments are the Rockwell and Scleroscope machines. On large massive parts it may be found that the Scleroscope is the only instrument which can be used. In general, the Rockwell hardness testing machine is to be preferred whenever it can be used. Hardness tests are made on Rockwell C scale although the A scale must be used for light cases under 1/32 in. deep.

It is well to remember when testing cold drawn or hot rolled steels which have not been turned that a decarburized surface may be present. Such areas will be soft to test and should be removed for obtaining true hardness tests and best wear resistance in service. One steel mill markets carbon corrected cold drawn steel. The correction is accomplished at the mill in atmosphere furnaces by adding carbon to the decarburized depth until this area possesses the same carbon content as the body of the steel.

Case depth determinations are made on sample pieces upon which a production run is duplicated. The sample can be fractured and examined.

Another method of checking case depth is to grind a representative cross-section and then acid etch. The etching agent is a dilute solution of nitric acid in alcohol or water.

Based on a paper presented at the 50th Annual Meeting of the International Acetylene Association, Mar. 29, 1950.

How to Weld Corrosion Resistant Materials

by W. G. SCHERER, Chief Engineer, Superior Welding Co.

By using correct procedures and adequately trained personnel, welds that are no more susceptible to corrosion than the unwelded areas can be made in most corrosion resistant materials.

• WELDING IS OF prime importance in the fabrication of corrosion resistant materials, because it permits the material to be bonded into essentially a unit structure. When the welding is properly done, there are gains in strength, in leakproofness, and in corrosion resistance. At the same time, it must be recognized that the weld area is the critical area so far as corrosion resistance is concerned. The metal has been heated to the point of fusion, with consequent changes in the metallurgical structure, and frequently in the chemical composition of the base metal. The introduction of filler metal also complicates the problem. With proper attention to procedure, and with adequately trained personnel, welds can be made in most of the corrosion resistant materials that will not be more susceptible to corrosion than the unwelded areas.

Metals and alloys intended for use where resistance to corrosion is a principal factor include a very wide range of structural materials. If corrosion be limited to such severely corrosive conditions as exist in the chemical industry, the list of widely used materials is shortened to such metals and alloys as stainless steel, nickel and certain of its alloys, copper and certain of the bronzes, and aluminum. The list must include both the solid alloy and the clad metals, however, for the advantages of cladding are being generally recognized today.

Preparation for welding includes cleaning and bevelling. Any standard method of mechanical cleaning is suitable for most materials. Bevelling can be done by (1) machine cutting, as with a planer, shaper, or milling machine; (2) punching; (3) arc cutting with the hollow rod; and (4) cutting with the carbon arc. The smoothness of the bevelled surfaces will be in the above order.

Welding stainless steel liner for tank.

Nickel and Nickel-Clad

Nickel can be cut satisfactorily by all of the listed methods except the carbon arc. Butt welds should have a 60-deg. groove—30 deg. on each plate. The root pass should be made with a small rod, and the second pass can use a heavier build-up rod. A coated rod of pure nickel should be used for all welds. After the groove has been filled from the bevelled side, the weld should be chipped from the opposite side and then welded.

In sections ½ to ¾ in. thick the nickel should be preheated a few hundred degrees to improve the flow of the metal. The current density can be as high as the rod will carry, up to the point that the coating on the rod is lost. Increasing the preheat will permit carrying the current density higher.

With nickel-clad steel the danger of iron pickup is the paramount problem, and the technique is developed to control this. This is one of the most difficult clads to weld, as the iron may boil up into the nickel weld on the first nickel pass to as much as 5% iron. Part of this iron can be carried up into subsequent passes, the final weld containing enough iron to impair its corrosion resistance seriously.

The steel side is bevelled down to within 3/32 in. of the nickel layer. The first pass is made with a steel

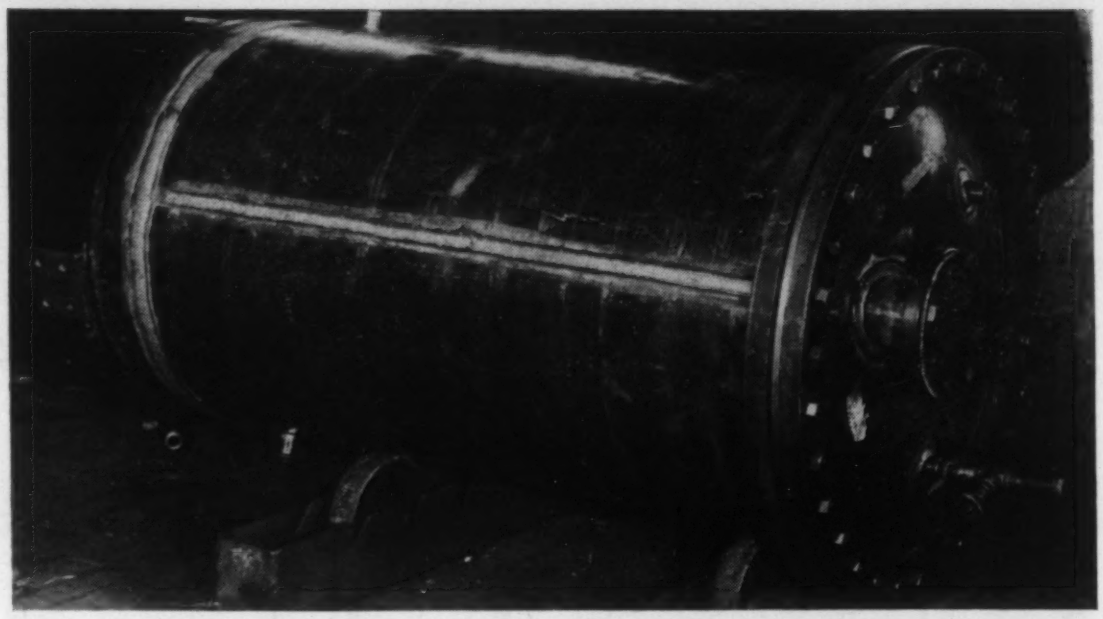
rod, taking care not to burn through into the nickel. Successive passes fill the groove on the steel side, and the work is then reversed and nosed out on the nickel side into the steel layer. The groove must be cut to the region of complete penetration—possibly ⅛ in. into the steel. Using a pure nickel rod, the first pass is made on the nickel side, and a second pass fills the groove. The final bead should be 99 to 100% nickel. Testing the weld with ammonium thiocyanate paper will indicate the presence of contaminating iron.

Stainless Steels

Stainless steel requires special cleaning methods for most work. Mechanical cleaning by sandblasting, combined with chemical cleaning in a bath of 20% nitric acid and 4% hydrofluoric acid, will remove any stains and also passivate the metal. This is effective even with hot-formed plates, where a closely adhering black oxide scale must be removed. Bevelling for the weld can be done as for nickel, with machine cutting the preferred method.

Arc welding of stainless steel requires that the rod be slightly richer in alloy content than the base metal, as part of the alloying elements will be lost in the arc. Rods for welding the various types of 18:8 stainless steel can be of 19 chromium-9% nickel to 25-20 alloy content. The use of titanium or columbium as a stabilizing element against carbide precipitation is now well established, as is the use of special grades of stainless very low in carbon content when welding is to be done. With the lighter gages of stainless steel, helium shielded arc welding offers the advantage of faster welding with less danger of burning through the metal. Argon welding is also used. Argon is heavier than air, and so forms a better blanket. However, there is more difficulty in striking and holding an arc at amps. below 30 with argon gas.

Stainless-clad stock can be prepared for welding by cutting with machine tools, punching, or by cutting with the hollow rod. Arc welding this material resembles that for nickel clad stock in technique. The welding starts from the mild steel side. The rod should be of 25 chromium-20% nickel composition rather than the 19-9 rod commonly used for solid stainless sheet. The same caution as with nickel-clad steel must be exercised against contaminating the weld metal on the stainless side with mild steel from the reverse side, though the richer alloy composition of the rod will compensate for a certain amount of pickup.



Above—A copper alloy (Herculoy) vessel which was welded with the carbon arc process. Close-up of this weld is shown at left.

Nickel Alloys

Monel and Inconel are not cut with the flame, but can be cut with the carbon arc or with the hollow rod. In using the carbon arc, a single carbon rod is used, ground to a pencil point. The current can be about 400 to 600 amp. The metal is most easily cleaned by making a paste of the following composition:

Fuller's earth	10 lb.
Lampblack	1 lb.
Hydrochloric acid, 20°Bé.	1½ gal.
Water	1½ gal.

After mixing the ingredients to a paste, the mixture is applied at room temperature with a paint brush, and permitted to stand for at least 1 hr., or preferably overnight. It is then rinsed off with warm water.

For solid metal the rod should be of the same composition. With the clad metal, technique and precautions are similar to those for clad nickel. Welding of Inconel clad stock can be done with a rod of 80 nickel-20% chromium for the alloy side; pickup of a few percent of iron during welding, combined with the loss of a few percent of chromium in the arc, will bring the weld metal to approximately the same composition as that of the base metal.

Copper Alloys

Silicon bronzes, of the type of Everdur, Herculoy, and Olympic bronze, are best cut with the carbon arc or the hollow rod. They can be arc welded with a rod of the same composition as the base metal, or with the carbon arc and a bare wire of the same composition. In the latter case the wire supplies filler metal only. The weld can be cleaned with muriatic acid.

While copper can be cut with the carbon arc or the hollow rod, machine cutting is decidedly preferable. If arc cutting is used in metal preparation, about an inch of stock will be lost, and its loss must be anticipated in the layout. Carbon arc welding is usually preferable on copper, with silver brazing for critical work and small pieces, and the standard alloy brazing for heavier work or general work. The work can be forged—beaten with hammers—while still red hot to improve grain structure.

Aluminum alloys used for corrosion resistance are usually 2S or 3S. The work is machine cut, and welding can be done by the shielded arc method, or with the oxyhydrogen flame, or by the heliarc process.

For additional information on the welding of corrosion resistant materials, see MATERIALS & METHODS, Jan. 1950, p. 53, and Feb. 1950, p. 57.—The Editors.

New Hard Coating Gains Wear Applications for Aluminum

Abrasion resistance of weight-saving aluminum alloys can now be improved by use of an electrochemically-produced hard coating.

● A "FILE-HARD" COATING for aluminum which makes this light metal eligible for many applications previously monopolized by alloy steels has been developed by The Glenn L. Martin Co.

Until now, it has often been necessary to use high-strength alloy steels, surface-hardened carbon steels or chromium-plated steels for structures requiring high scratch and wear resistance. In many cases the superior strength of the steel part was of no advantage since wear resistance, not high strength, was the primary requirement. Now, this new hard coating is expected to allow industry to take better advantage of the light weight of aluminum, particularly in the manufacture of aircraft.

Although the exact nature of the hard coating has not been publicly revealed, its properties and the characteristics of the process suggest that it is basically a film of aluminum oxide. This article will discuss briefly these properties and characteristics, in addition to outlining the present and potential applications of the new coating, which has been labeled "MHC" finish.

Process Characteristics

The MHC finish is applied electrochemically to aluminum and aluminum alloys to produce a nonmetallic, file-hard, highly heat-refractive surface strongly bonded to the base metal. Color of the finish ranges from light to dark grey, depending upon the alloy and the thickness of the coating. Coating thicknesses run from 0.0001 to 0.006 in., a thickness of 0.002 in. being used for most abrasion resistance applications. This standard thickness exceeds the usual range of 0.0001 to 0.0008 in. used in conventional anodizing of aluminum.

The electrochemical process provides a coating which is integral with the base metal. Since the base metal participates in the reaction, its thickness is reduced by an amount which varies with the thickness of the applied film. The amount of growth exhibited by coated surfaces for several different film thicknesses is given below:

Film Thickness, In.	*Growth, In.*
0.0004	0.00035
0.0008	0.00075
0.0020	0.0011
0.0044	0.0015

Thus, parts which are to be given the standard 0.002-in. hard coating are normally processed to a minus tolerance representing about one-half the thickness of the proposed finish. On the other hand, it is sometimes possible to make use of the dimensional growth of parts in the MHC process. An example is the case of worn or undersize gears which, given a light coating, no longer tend to backlash. This permits salvage of gears that would otherwise have to be replaced.

The best abrasion resistant coatings are obtained on smooth surfaces such as those produced by rolling, forging, grinding or machining. However, rough surfaces, like those found on castings or after sand or grit blasting, can be coated successfully for some purposes. Sand cast, grit blasted, forged and rolled parts may contain small foreign particles imbedded in their surfaces that will lead to minute imperfections in the hard coating.

Hard coatings should be applied as a final step after all machining, grinding, filing, drilling and related operations. Generally, surface smoothness is closely maintained in the coating process. For example, rolled 75S-T6 sheet samples having a finish of 4 RMS microinches showed a 16 RMS finish after application of a 0.002-in. coating. Since the process offers high throwing power, uniform coatings can be applied to irregular shapes and recessed areas.

When specific areas of parts are to be hard coated, and the rest of the part anodized or left untreated, these latter areas are masked off. Although the hard coating has better corrosion resistance than conventional anodized surfaces, the cost factor often makes it advisable to anodize the areas of a part which are not exposed to wear, *e.g.*, areas where fittings are riveted to a structure. When non-hard coated areas are to be anodized, the whole part is usually anodized first, then masked for selective hard coating.

The MHC hard coating is relatively expensive, as currently applied on a purely experimental basis in the Martin engineering laboratory. On a production scale, it is believed that the process would compare in cost with such operations as the heat treating of steel. In any case, developers of the process say it would be cheaper than hard chromium plating.

Coating Properties

Wear Resistance—The most significant property of the MHC hard coating is, of course, its wear resistance. In this respect, a good picture is given by the graph (Fig. 1), which shows the results of wear tests on the MHC coating compared with results obtained on other materials and coatings. After 50,000 cycles, for example, MHC samples showed only half as much wear as did cyanide case-hard-

ened steel. These standard tests were performed on a Taber Abrasion Tester, using rubber-bonded abrasive wheels with a 1000-gram loading.

Hardness—Accurate hardness values of the coating have not been obtained because the indentor mechanisms of standard hardness testing equipment produce too deep an impression for reliable results. However, the coating can be considered as approximately file hard.

Ductility—Tensile tests of coated 0.060-in. 75S-T6 Alclad and 0.065-in. 75S-T6 bare sheet show that although the coating has slight effect on tensile and yield strengths of the materials, it does cause some loss in ductility. This is not unnatural for a material of such high hardness. On right angle bends over a ¾-in. rod, a 0.002-in. coating spalls off on the compression side of the bend and forms fine checks on the tension side. The coating has good impact resistance, although it can be dented and slightly chipped under repeated sharp blows of a hammer.

Endurance Limit—The MHC coating produces a marked drop in the endurance limit or fatigue life of the metal. This is illustrated in Fig. 2 by the results of repeated cyclic stressing of 0.190-in. gage 75S-T6 sheet with and without 0.002-in. MHC coatings. This trend is to be expected when hard coatings are employed over softer materials. Nevertheless, hard coated structures subject to repeated loading in tension, bending or torsion should be used only after functional tests have proved the application satisfactory.

Electrical Conductivity—The hard coating is a non-conductor and serves as a good insulator. Standard anodic films show a voltage breakdown of about 340 v. against a range of 500 to 3700 v. for the hard coatings.

Coefficient of Friction—A definite coefficient of static or sliding friction has not yet been determined, but preliminary tests indicate that the MHC film has a lower coefficient than that of untreated metal. Sliding wear tests involving various combinations of hard coated and bare metal surfaces with lubricants indicate that maximum resistance to wear can be obtained with a lubricant of molybdenum sulfide or graphite grease.

Heat Resistance—Because of the difference in coefficient of expansion between the base aluminum alloy and the hard finish, checking of the MHC film will occur when temperatures exceed 200 F. Under such conditions, however, the coating shows no tendency to spall, and the checking does not materially affect its corrosion resistance. Processed surfaces also provide a certain amount of heat-insulating protection for the base metal when exposed for short periods to extremely high temperatures. Tests show that 24ST sheet with a 0.002-in. hard coating will stand up to an 1800 F Bunsen burner flame for 1 min., whereas uncoated sheeting begins to blister after 15 sec. and warps considerably.

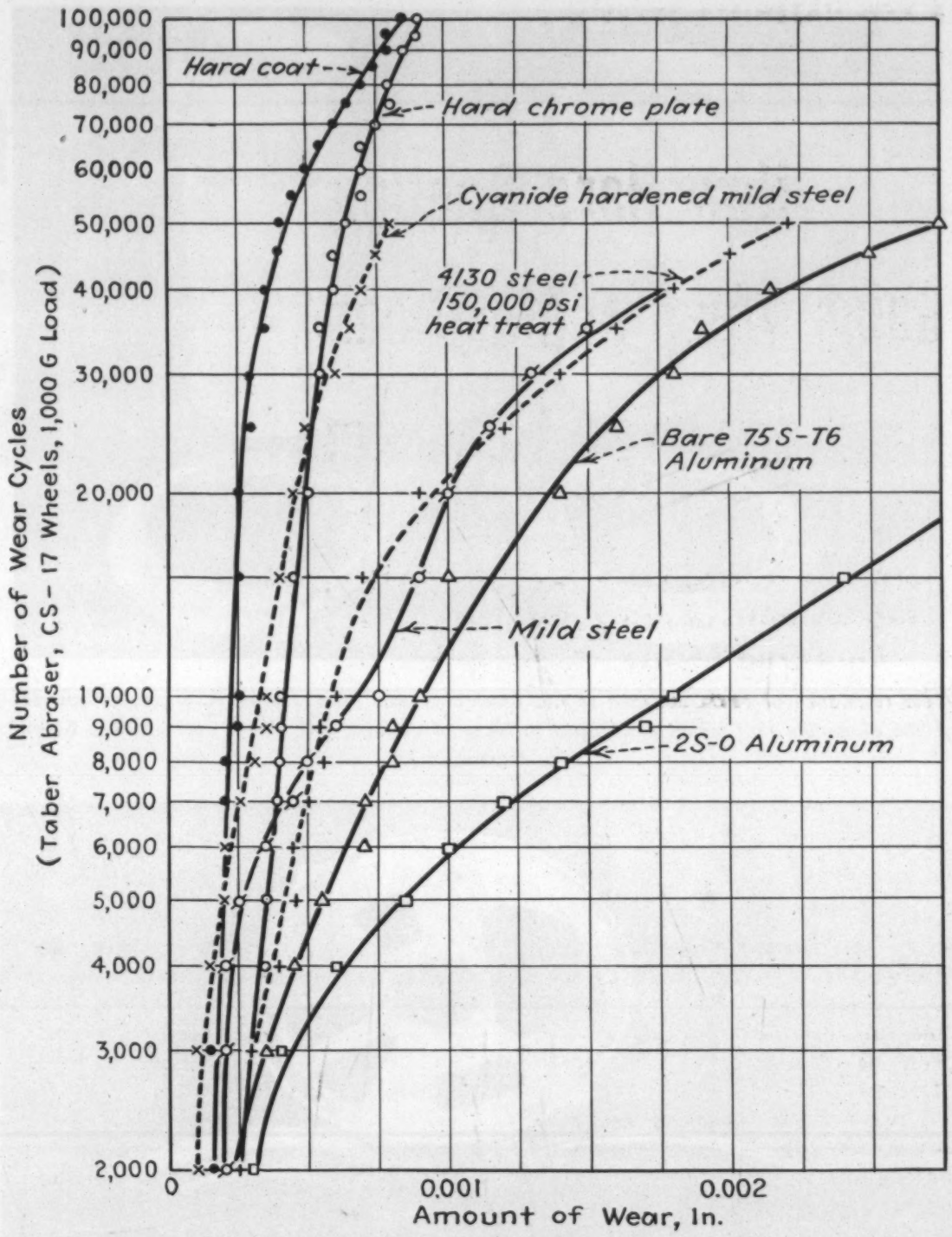


Fig. 1—Graph compares wear resistance of MHC hard coating with that of various other materials and coatings.

Corrosion Resistance—The coating is reported to provide excellent resistance to atmospheric and salt water corrosion. Test panels with 0.002-in. films, subjected to these conditions, have shown little corrosion after 14 months of continuous exposure. Though proof against most common chemicals, the MHC finish is attacked by strong acids and alkalies.

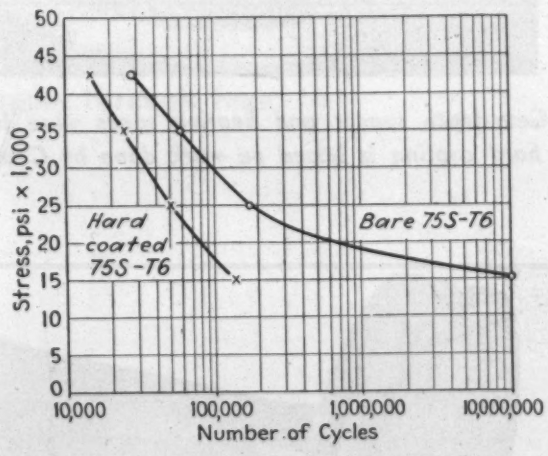
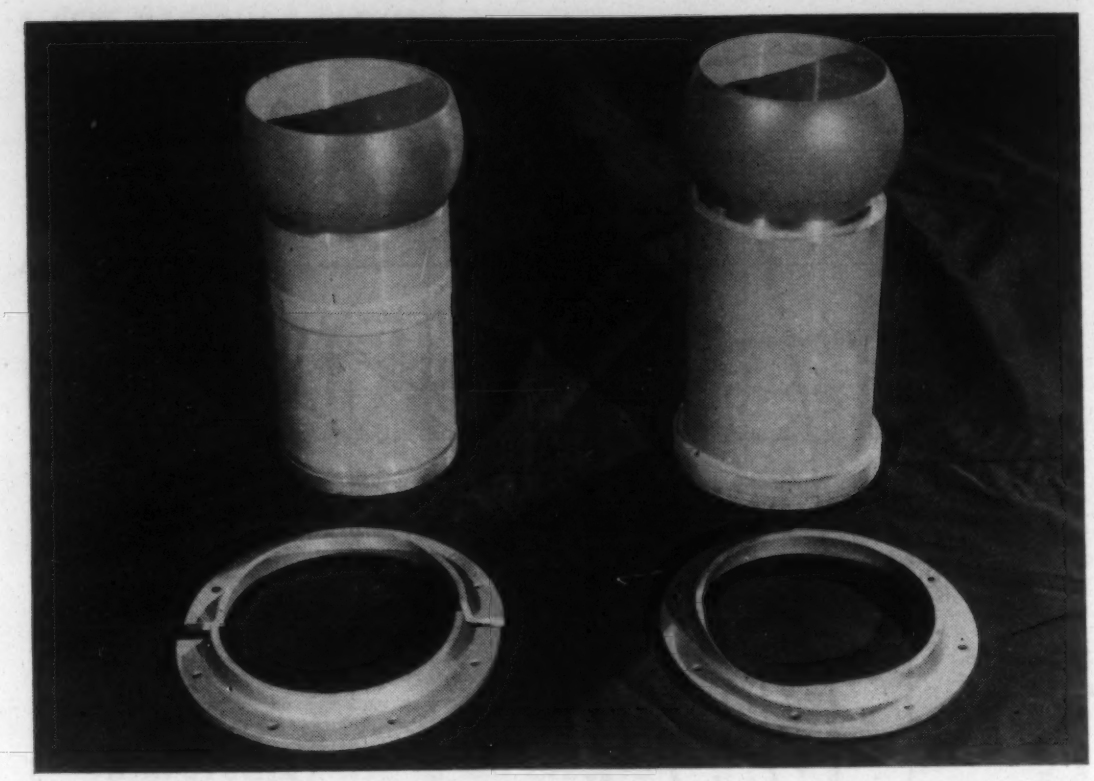


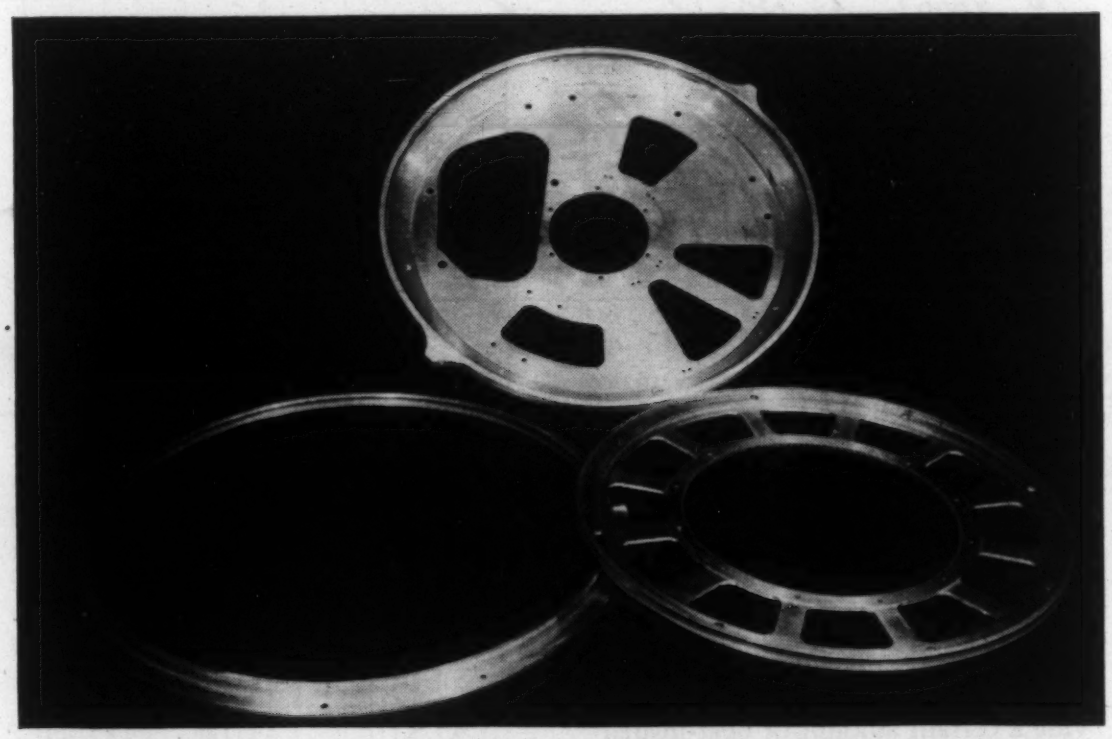
Fig. 2—The marked drop in endurance limit of hard-coated aluminum is illustrated by this S-N curve.

Applications

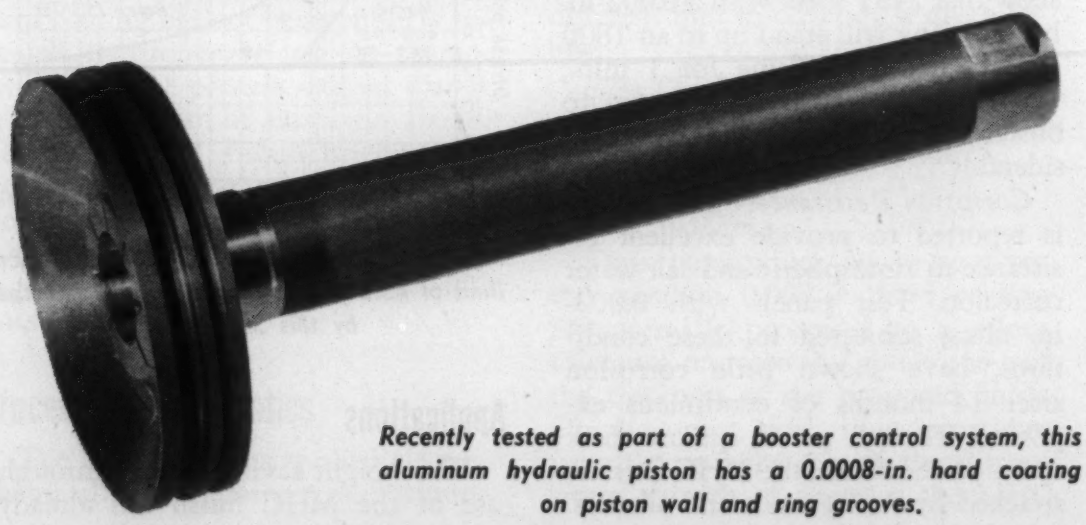
The weight saving gained through use of the MHC finish has already



Wear resistance of these ball-and-socket assemblies was increased by hard coating outside of the aluminum ball joints and entire surfaces of collars. (All photos courtesy The Glenn L. Martin Co.)



Gear-teeth spacer and bearing races were hard coated on all surfaces. Development of hard coating is based on work done by Charles F. Burrows, Martin research metallurgist.



Recently tested as part of a booster control system, this aluminum hydraulic piston has a 0.0008-in. hard coating on piston wall and ring grooves.

proved of considerable value in aircraft construction. In a typical instance, treated aluminum bearing races saved 40 lb. over the conventional steel assembly.

Although laboratory development has been under way for over two years, exploration of the practical uses of the new finish is believed to have barely scratched the surface of the possibilities. However, coatings have already been applied successfully to such widely dissimilar items as gears and pinions, surveying instrument parts, turbine impeller blades, hand tools, swivel joints, friction locks, leading edges of high-speed airfoils, cams, pistons and leg braces for paraplegics.

The finish is applied to aluminum and aluminum alloys containing less than 5% copper, either in wrought or cast form. Wrought alloys, in order of decreasing resistance to abrasive wear, include: 61S, 75S Alclad, 75S, 24S Alclad, 14S Alclad, 52S, 2S, 24S and 14S. Cast alloys are 645, 220, 355, 356 and 195. Alloys other than these have not yet been treated.

The MHC hard coating is already being tested on the leading edges of high-speed airfoils, which are susceptible to wearing by the surface attrition of dust and rain. Helicopter rotor blade tips, which must often be "revved up" in clouds of dust, sand or cinders, represent a similar adaptation.

Many direct substitutions of hard coated aluminum for steel are being made in moving parts for Martin airplanes, as well as for static surfaces exposed to severe scuffing or other forms of wear. A typical case is that of an aluminum carburetor deck plate in the Model 2-O-2 airliner. The wide variety of aircraft applications also includes cylinders, bearing surfaces, jackscrew threads (which would seize if uncoated), airplane door thresholds and mechanics' wrenches.

Fields outside the aviation industry are expected to provide additional applications for the coating. Sand and abrasive dust particles to which hinges are exposed have caused a high percentage of failures to aluminum ankle joints. But a sample lot of 5000 leg braces of the type used by disabled veterans recently passed a series of laboratory tests for wear resistance after the ankle joints were hard coated by the MHC process. The market potential in this application alone is obvious from the fact that there are nearly 10 million such leg braces in use today in this country.

Materials & Methods Manual

This is another in a series of comprehensive articles on engineering materials and their processing. Each is complete in itself. These special sections provide the reader with useful data on characteristics of materials or fabricated parts and on their processing and application

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Extruded Metal Shapes and Their Uses

by T. C. Du Mond, Editor, Materials & Methods

Extruded shapes in brass, aluminum and magnesium are a means of reducing production costs on a variety of products ranging from simple angles to complicated shapes. Those who have become aware of the possibilities of extruded shapes are constantly on the lookout to find shapes which can be extruded rather than cast, forged, rolled, machined or assembled. In this manual we present the basic facts about extruded shapes and show how they apply through four pages of interesting examples of their use.

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Introduction

Stated simply, metal extrusions are shapes produced by forcing the material through a die having an aperture of the desired shape. The operation can be compared to squeezing tooth paste from a tube. Pressure is exerted and a plastic material is forced out in a continuous ribbon which takes the shape of the opening.

Extruding is a relatively old process, but the engineering world at large has not paid too much attention to the possible use of extruded shapes to reduce costs as well as to make better products. For many years the common shapes of bar, wire and rod in copper and copper alloys have been extruded. More recently architectural and structural shapes in brass, aluminum and magnesium have been extruded rather than rolled. Even newer is the practice of using extruded shapes as a means of making mechanical shapes in all of these materials.

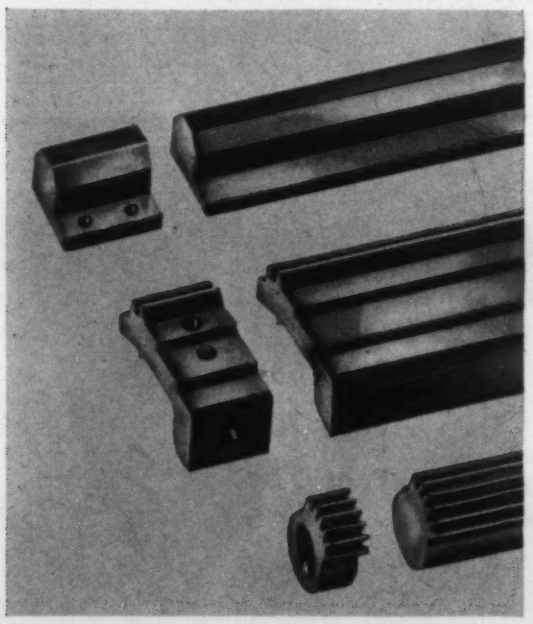
The latest development in the field of extrusions in the rumor of scattered successes in extruding steel. From France comes a process which may ultimately give certain steels the advantages now enjoyed by brass, aluminum and magnesium.

Though most of us are unaware of it, we are seldom more than a few feet away from extruded shapes. For example, most modern office buildings use tons of extruded shapes in windows, doors, railings, cornices and decorative trim. Most commercial and military aircraft carry hundreds of pounds of extrusions in such shapes as spars, spar caps, flooring, accessory equipment and, in some cases, in the outer skin. Trucks, buses and trailers account for an increasing tonnage of extruded metals in flooring, roof rails, sills, corner posts and body trim. In the home, much hardware, including drawer pulls, hinges, padlocks and many other objects, started as extrusions. The frames of millions of lady's handbags are extruded, as are belt buckles and other articles of personal use.

To appreciate the widespread use of extruded shapes, we have but to note the fact that one primary metal producer and fabricator has an active inventory of more than 30,000 extrusion dies. Other companies are building comparable collections of dies.

Theoretically, all metals can be extruded, but not all can be so formed economically. Brass, aluminum and magnesium are the most commonly extruded metals. Several alloys of all these metals can be produced in simple as well as complex shapes. Nickel and high nickel alloys are being extruded as tubing and in a few simple shapes, and now, swift progress is being made in finding ways of extruding steel.

The use of cut extruded shapes has been likened to slicing a piece of bread from a loaf. These brass shapes indicate what can be done by using extruded shapes. In each instance, completing of the part requires only a few simple machining operations, such as drilling or tapping. (Courtesy American Brass Co.)



The Extrusion Process

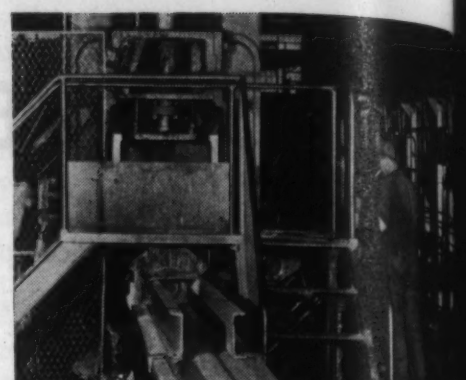
The method used to produce extrusions of the type concerned with in this manual is commonly referred to as billet extrusion. Most extruding is done on horizontal hydraulic extrusion presses.

Presses in operation today range in size from 500 to 5500 tons capacity, and will handle billets 3 to 20 in. in dia. The billets are heated to a plastic state immediately before being placed in the billet container of the press, in order that the metal will flow through the die.

Extruding is a rather slow process when compared to rolling, for example, with speeds ranging, in common alloys, from a few inches to a few feet per min. Pressures required to produce extruded shapes vary from 50,000 psi. upward to as high as the 170,000 psi. reported for steel.

Best metal properties result from using a relatively high reduction from billet size to finished shape. With most of the commonly extruded alloys, the ratio ranges from 20 to 40 to 1.

After metal passes through the extrusion dies, it must be straightened



Extruded shapes are produced in brass, ma nesium and aluminum. Here in the mill Titan Metal Manufacturing Co. a brass sha is seen coming from the extrusion press.

to bring it within normal limits straightness. With some alloys of c tain metals, subsequent drawings required to attain final shape and acc racy requirements. However, the gre est advantage in the use of extrud shapes accrues when no further ope tions are required.

While an overwhelming percenta of the tonnage of extruded shapes no produced is in structural or archite tural shapes, a field of increasing i portance is in the production of e truded shapes, which are cut into sho pieces to provide finished parts. Al looming large is the use of extrude shapes to provide blanks for forgi It is to shapes of these types that t manual will be devoted.

Extruded shapes of the type that a cut to shorter lengths and convert into finished parts with, at most, a fe simple operations fulfill a set of r quirements all their own, but at t same time they do compete with oth metal forms. In certain cases extrud shapes have replaced castings; in oth instances, forgings. Perhaps the clos competition is between extruded shap and rolled shapes. However, many e truded shapes now being made a in forms that could not have be achieved previously except by machi ing or by joining two or more shap into a completed part.

It is difficult, if not impossible, establish any rigid set of conditio against which any imagined part c be measured to determine whether should be made as an extrusion. P haps, though, the examples given he of where and how extruded shapes ha saved money and provided better pro ucts will stimulate the imaginations other engineers.

Where Extruded Shapes Are Used

As indicated, it is not possible to fine a set of conditions which will mistakably point to the use of exded shapes. Considerable study and agination is often needed to see here the use of extruded shapes will ercome disadvantages or limitations some other metal form.

If an extrusions expert were to be ked: "Why should I use extrusions?" most likely would be told:

"Because in extrusions you can place etal exactly where it is needed to eet anticipated stresses."

The truth is a little less broad than at, however, since extruded shapes e limited to those pieces which ve uniform cross-sections their entire ngths. Within these limitations, the tement is true.

Four basic situations cover the bulk circumstances under which extruded apes should be considered. There are her instances where shapes of this ature should or could be used, but ese are the most important:

1—When a more efficient disposal metal is desired than is obtainable ith rolled shapes or other metal forms.

2—Where several parts are now ined to provide a small assembly.

3—Where shapes are required that uld not be obtainable without diffilt machining.

4—Where short pieces of the exusion can replace small castings or rgings.

As can be seen, the listed conditions over a multitude of metal shapes. herefore, many other considerations ust be made before deciding whether n extruded shape will be the answer any production problem.

First, one must determine whether e materials in which extruded shapes e readily available will provide reuired physical and mechanical propties. In other words can brass, alumium or magnesium give strength, finh, corrosion resistance and other charcteristics that are needed.

Next, it is important to determine hether the quantity is right for exuding. Some shapes can only be made extruding, but many could be made other methods. Depending upon the mplexity of the part, it might be conomically practical to make extruon dies for only a few hundred unds of material. On the other hand, the shape is one that could be proced by rolling and the quantities are fficiently high, then rolling would be heaper. Where quantities are very small, machining or casting probably would be less expensive.

Equally important is the need to know whether a slight redesign of a product would permit the use of extruded shapes.

Complexity of Shape

Much of the value of using extruded shapes applies to highly complex shapes. For example, extrusions are ideal where undercuts are required, or where thin sections must join thick sections or where compound curves are involved.

This woodcutter's wedge shows that simple extruded shapes have their place, too. Formerly this magnesium shape, which is 10 in. long, was produced as a sand casting.

But by no means can the savings inherent in extrusions be confined to difficult complex shapes. To illustrate, we need but to think of extruded tubing where short lengths are sliced off and used for various purposes. Typical of where a simple extruded shape replaced a casting is a wood cutter's wedge. This simple triangular wedge was formerly made as a casting. Now long lengths are extruded and merely cut to proper length for use. Millions of feet of angles, I's, T's, Z's, W's and channels are produced each year by extruding.

Simple shapes such as this can be made more easily by extruding than by rolling, braking or most other methods which could be considered. Pieces are cut off to length as needed.

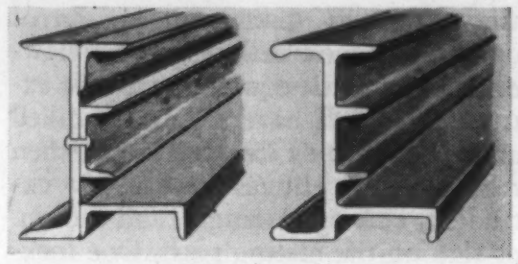
Although the size in which extruded shapes can be produced is limited to present-day press capacities, it is not necessarily true that large forms cannot be made by extruding. For instance, cylinders having diameters as large as 60 in. have been built up from extruded segments.

Where Used

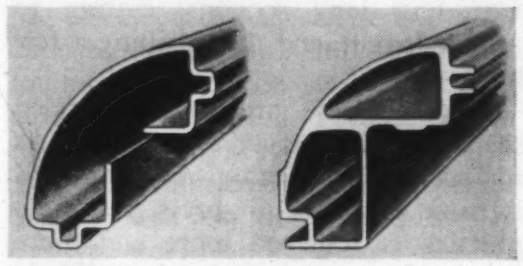
Without running through the gamut of American industry, it is impossible to list all, or even most, of the places where extruded shapes are used. Their uses fall into three major categories.

First, there are those instances where the finished part merely requires that the part be cut to length from the complete extrusion. Most architectural and structural parts do not require any additional work before use. Other parts include splined tubing or shafts with keyways extruded in place, gears, finned heat exchanger tubing, parts formerly made as rolled shapes welded into an assembly, and many special shapes that defy simple description.

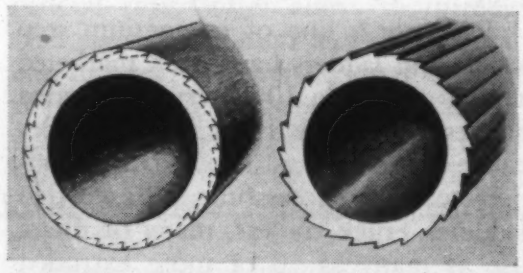
A second group includes those parts which are made by adding one or more simple machining operations to a cut extruded shape. Such parts would include hundreds of shapes made ready for a screw machine in addition to plain extruded hexes, rounds, squares and tubing. Drawer pulls are other



Two or more rolled structural shapes can be combined into one extrusion, thereby eliminating joining costs.



Permitting as they do, changes in cross-section, extruded shapes can be more easily tailored to meet specific requirements than can rolled or formed sheet sections.



Sections made by cutting extruded shapes to length can often replace parts machined from bar stock or tubing.

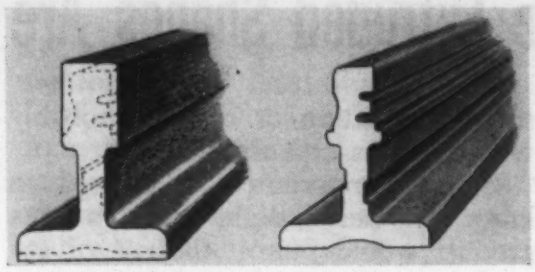
examples. With most, all that is needed to complete the part is the drilling and tapping of two holes. All brass extruded shapes that involve internal openings require drilling. Cam followers for automatic equipment can be extruded, cut off, have a groove milled and a hole drilled in each and are then ready for use. Hinges are made by extruding, cutting to length, and milling or slatting the mating parts. One inexpensive camera is made by using as its framework a complex extrusion which is finished by cutting lens openings, drilling a few holes and enameling. Padlock bodies and sleeves are made by extruding long sections, cutting to proper length, and then drilling a few holes.

Finally, there are those extruded shapes which are cut to make blanks for subsequent forging. Although this is most prevalent in brass, the same practice is followed more and more in aluminum and magnesium. Many plumbing fixtures are made by such processes. Faucet handles, fittings and valve sections are typical. Small piston rods are being forged from extruded blanks, as are many other small forgings.

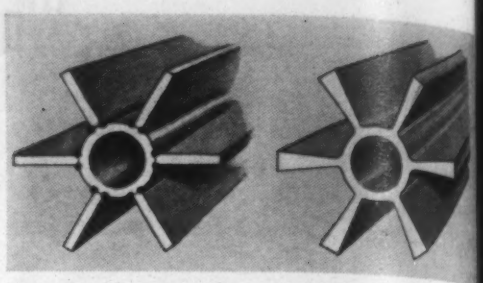
Recently a line of magnesium step stools and ladders have been marketed which are made 100% from extruded shapes. Assembly is by welding. Because of the savings involved, these ladders compete successfully with wooden ladders. Truck trailers, many of them, use as many as 10 or more extruded shapes. Buses of certain kinds use up to 30 different extruded shapes. A typical airplane wing might use eight or more different extruded shapes. Many pieces of textile equipment use extruded shapes for such parts as lay beams, roller beams, snug rails and top and bottom snugs.

The list could be continued indefinitely, but the examples cited show the enormous potentiality of extruded shapes.

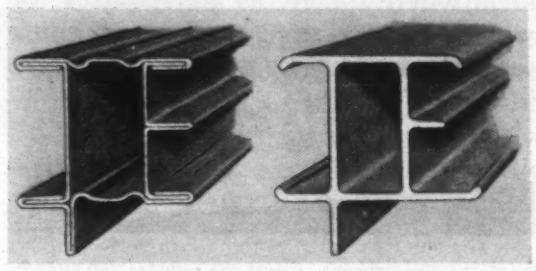
As an example of how an extruded shape develops, we can take the case of an I-section. When first used, the piece started as an assembly of a piece of sheet and four angles. Next, two extruded T-sections were joined together by means of thin plate to form the I. Finally the entire shape was extruded.



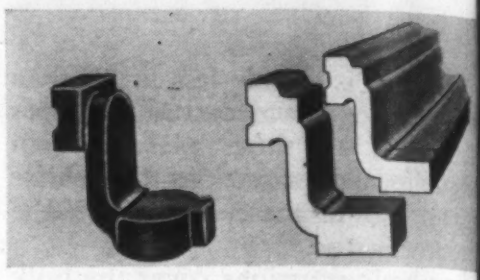
Long frame members can often be reduced in cost by redesigning the section to make it as an extruded shape and thereby eliminate the need for extensive machining on a cast section.



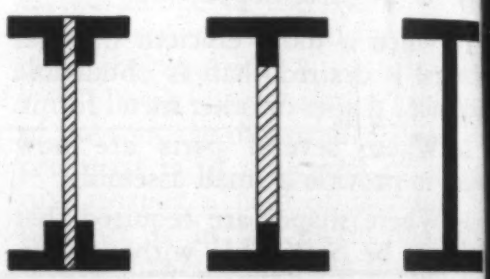
Cost is reduced and accuracy increased by converting certain types of welded assemblies into a single extruded shape.



A gain in strength and stiffness often results when extruded shapes replace crimped tubular sections.



In many instances small castings, forgings or parts machined from bar stock can be redesigned to an extruded and cut shape.



Shown here is the progression of an extruded I section which began as a piece of plate and four angles. The next step was to join two T-sections to a piece of plate. Finally, the shape was made as one simple extrusion.

Advantages and Limitations of Extruded Shapes

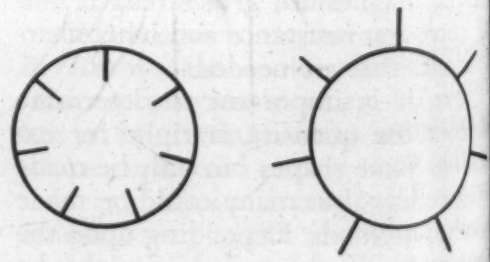
The advantages of being able to put metal where desired in extruded shapes are many. For one thing, much money is saved by the elimination of machining chips. At the same time, by placing metal only where it is needed, no more metal is used in the part than is necessary. These are, of course, in addition to the structural and mechanical advantages of putting the metal where it will do the most good.

On the favorable side, extruded shapes are much cheaper than many competitive metal forms; the metal is dense, homogeneous and free from porosity; the method can produce large-diameter, thin-walled tubing; reentrant angles present no difficulty; moderately short runs are practical; increases or decreases in section thickness are easily handled; sharp corners are possible.

Limitations include the fact that dimensional tolerances are not as close as in machined parts; production speeds are slow, as compared to rolling; size of shape is limited, because of die and press restrictions.

To elaborate:

As an example of putting metal where it is wanted and needed, there are the bulb angle shapes used so extensively in aluminum and magnesium



Finned tubing of many types can be produced as extruded shapes. For flat sections the material can be extruded as a circle and then cut and straightened, or extruded flat. An extrusion such as this shows how sharp corners and fillets can be extruded.

rcraft production. Single and double lb angles are provided to attain eater stiffness and strength.

Designers using magnesium take adntage of the preplacing of metal. agnesium has a low compressive eld strength and high tension yield rength. Therefore, shapes are often ade with more metal at the top than the bottom.

Nearly any shape that is extruded to rovide blanks for subsequent forging ould be cited as an example of preeaning metal.

osts

In practical quantities extruded apes can be produced inexpensively compared to competitive metal rms. Die costs are extremely modest hen compared to the die used for die sting or forging. As an example, me producers have a minimum harge of $110 for a shape die conined within a 3-in. circle. Cost then ises to about $300 for plain extrusion ies, and continues up to about $1500 r complicated shapes.

Buyers of extruded shapes usually ay for the original die. Maintenance nd replacement costs are assumed by he extruder.

Semi-hollow and hollow shapes are ore expensive than closed shapes in agnesium and aluminum. Hollow apes are not produced in the brasses, ecause the high melting point of the etals makes extruding of such shapes ifficult and costly.

The cost of aluminum and magnesium extruded shapes is affected to some xtent by the average thinness of shape. hapes are classified by using units nown as "factors." The factor for any iven shape is computed by dividing he perimeter of the shape's cross-section (in inches) by its weight per inear foot in pounds. Usually a thin hape will have a higher factor and, herefore, a higher price per pound. ven though the price per pound of hin shapes might be high, their light eight often makes the cost per piece uite low.

etal Quality

Metal formed by the extrusion proc-ss has mechanical properties that compare favorably with those attained in common wrought forms. As a matter of fact, extruded metal is classed as wrought metal. Metal quality is much higher than is possible in sand casting. This is largely due to the fact that in most extruding operations there is a volume reduction of about 20 to 1.

The kneading action of extruding eliminates practically all porosity and results in greater homogeneity of metal structure. In addition, the surfaces are smoother and freer of pits than are the majority of sand cast surfaces.

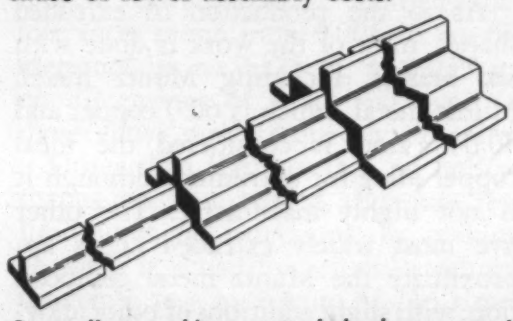
Design Advantages

Extruded shapes offer design possibilities that could only be attained in other shapes by expensive second operations. As an example, reentrant angles and undercuts can be provided without difficulty. The same is true of compound contours, which are often desirable, but usually difficult to attain.

One big advantage of extruded shapes is the ability to permit changes in thickness across a section, with increases and decreases provided as needed. Thin sections can adjoin thick sections. Wall sections can vary widely.

Sharp corners are possible, but it is best to provide corners and fillets with radii of at least 1/64 in. Sharper corners and fillets involve higher die charges.

Thickness of extrusions range, generally, from 0.050 in. to several inches. Thinner sections are being extruded. In general practice, hollow shapes cannot be extruded as thin as solid sections. Too, hollow shapes are not so easily attainable in the highest strength alloys, and usually are more costly in the larger sizes. Where it is possible, though, it is often less expensive to use the more costly hollow shapes, because of lower assembly costs.



Generally speaking, extruded shapes must retain a uniform cross-section for the entire length of the extrusion. However, it has been found possible to make stepped aluminum extrusions through the use of special production equipment. The stepped extrusions are being used for aircraft spar caps and similar sections. Stepped extrusions can reduce greatly the machining normally required to produce such shapes.

A common ratio of thickness to wide governs aluminum and magnesium extrusions, but the ratio varies with the alloy. Aluminum alloys, such as 3S and 63S, have a ratio of 8 in. wide to 3/32 in. thick; for 14S, it is 8 in. wide to ⅛ in. thick.

There are certain don'ts which apply to the design of extruded shapes or redesigning parts to take advantage of the extruding process:

These include:

Avoid extremely thin sections with large circumscribing area.

Avoid semi-hollow sections with unbalanced die tongues.

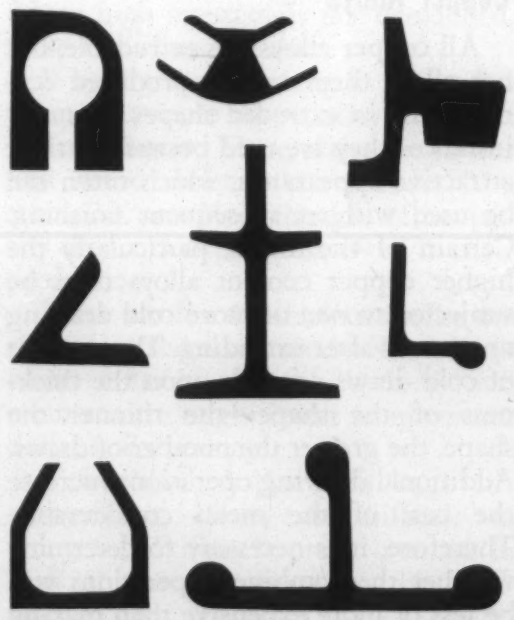
Avoid sections with extreme thickness variations; hollow shapes with unsymmetrical voids or with inadequate section thickness between voids.

Size

There is a definite limitation on the size of extruded shapes. The limits are imposed by the size and capacity of equipment available and practically possible. In addition, beyond certain sizes, the weight of hot extruded shapes would be sufficient to cause extreme bending and twisting. Distortion of this type would require more expensive straightening operations than are needed for the sizes currently produced.

Thickness, as mentioned, ranges from about 0.050 in. up to several inches. Some sections thinner than 0.050 in. are produced, but not as a general rule. Softer alloys in thinner sections in aluminum and magnesium are limited in cross-sectional dimensions by a circumscribing circle about 12 in. in dia. Stronger alloys have been made with cross-sectional dimensions contained within a 17-in. circumscribing circle.

There are ways of circumventing the size limitations. For instance, a W, V, or circular shape can be extruded and then straightened. An example of how this works has recently been publicized



The extruded shapes shown here are typical of those which can and are being produced in magnesium. They illustrate many of the design advantages of extrusions.

by Reynolds Metals Co. in announcing a method of making aircraft skin with integral stiffening. Circular shapes having an inside diameter of 8.858 in. and 11.86-in. outside dia. are extruded. After extruding, the shape is slit and then straightened to provide a section 28 in. wide. Thus far, skin sheet of this type has been produced in aluminum alloys 24S, 16S and 75S.

Dimensional Tolerances

Extruded shapes cannot be considered as highly precise shapes, although they can be made to much closer tolerances than, for comparison, sand castings. It is probably accurate to state that the precision of extruded shapes lies somewhere between sand castings and machined parts.

Tolerances to which extruded shapes are produced include straightness, flatness, twist, as well as section thickness, angles, contours and corner and fillet radii.

Here are some of the tolerances cited on commercial parts:

Flatness: On a 6-in. width the tolerance would be ±0.024 in., or 0.004 in. per in. of width.

Straightness: On a 5-ft. length, a deviation for a straight line of 1/16 in. is permitted. This increases to 3/8 in. in 30-ft. lengths.

Cross-Sectional Dimensions: Alco, for example, offers tolerances ranging from ±0.006 in. on thicknesses less than 0.125 in. up to ±0.080 in. on 14- and 15-in. thicknesses or widths.

Cut Ends: Permissible deviation from the square, 1 deg.

Curved Surfaces: Allowable deviation from a specified contour is 0.004 in. per in. of chord length with a minimum of 0.005 in. This tolerance does not apply to more than 90 deg. of arc.

Speed of Output

While the rate of output of extruded shapes has no direct bearing on the ultimate user of the shapes, costs can be affected, particularly if large quantities are required.

Speeds range from 1½ to 700 ft. per min., depending on the material, the alloy and the shape being extruded. The highest speeds are in some of the alloys which are not ordinarily produced as shapes. Magnesium is extruded at speeds of from 4 to 100 ft. per min., aluminum somewhat faster, and copper alloys a little slower. Highest speeds are attained with nickel alloys and steels.

Extrudable Metals

Theoretically, most metals are extrudable, but there are practical limitations which confine the large scale production of extruded shapes to brass, aluminum and magnesium. Extensive research has been expended on solving the problems of producing steel shapes by hot extruding. Certain shapes are extruded in other materials, but few if any are made in the forms in which we are interested in this manual.

Copper Alloys

All copper alloys are extrudable, but not all of them can be produced economically in extruded shapes. In many instances they are used because of their attractive appearance, which often can be used without subsequent finishing. Certain of the alloys, particularly the higher copper content alloys must be subjected to one or more cold drawing operations after extruding. The number of cold draws depends upon the thickness of the shape—the thinner the shape, the greater the number of draws. Additional drawing operations increase the cost of the metal considerably. Therefore, it is necessary to determine whether the combined operations will be less or more expensive than making the shape by some other method.

High copper alloys are used in extruded shapes for electrical applications, because of the good electrical conductivity. Extruded shapes in these alloys are generally to provide a blank for subsequent forging; to provide a convenient size of bar, rod or wire; or to reduce these sizes quickly and inexpensively during processing.

As to the production of extruded shapes, most of the work is done with six brasses, including Muntz metal. Muntz metal, which is 60.0 copper and 40.0% zinc, is considered the ideal copper alloy for extruding, although it is not highly machinable. The other five most widely extruded alloys approximate the Muntz metal composition, with slight additions of other alloying elements which improve strength and machinability or improve corrosion resistance.

The copper alloy most widely used in extruded shapes is extruded architectural bronze, with forging brass a close second. These are followed by naval brass and manganese bronze. The tensile properties of all of these are reasonably close, but machinability falls off considerably in the last two alloys. Where considerable machining is to be done, free cutting yellow brass is used. Finally, where average properties and other characteristics are needed at relatively low cost, Muntz metal is used.

It is possible, but not practical, to extrude hollow shapes in brass. Therefore, shapes which require openings through the cross section are extruded as solids and machined. Even in these cases, savings can be considerable over casting or machining from the solid. With this one limitation, all the advantages of the extrusion process are applicable to brass extruded shapes.

Common Brass Extrusion Alloys

	Ten. Str., Psi.		Yld. Str., @ 0.5% Elong. under Load, Psi.		Wt. per Cu. In.	A.S.T.M. Spec.
	Hard	Soft	Hard	Soft		
Extruded Architectural Bronze	—	60,000	—	20,000	0.305	—
Forging Brass	—	54,000	—	20,000	0.305	B124
Naval Brass	63,000	56,000	35,000	22,000	0.304	B21 B124
Manganese Bronze	75,000	60,000	45,000	30,000	0.302	B124 B138
Muntz Metal	—	54,000	—	20,000	0.303	B124

Common Aluminum Extrusion Alloys

Alloy	Temper[1]	Thickness, In.	Weight, Lb. per Cu. In.	Typical Mechanical Properties		
				Yield Str., Psi.	Ultimate Str., Psi.	Elongation, % in 2 In.
2S	0	All	0.098			
	F	All	—	7,000	12,000	45
3S	0	All	0.099			
	F	All	—	10,000	16,000	30
14S	0	All	0.101	15,000	28,000	17
	T4	All	—	47,000	64,000	18
	T6	0.125-0.499	—	65,000	71,000	10
		0.500-0.749	—	68,000	74,000	10
		0.750 and over[3]	—	69,000	76,000	10
	T64	All	—	63,000	67,000	9
24S	0	All	0.100	15,000	31,000	16
	T4	0.050-0.249	—	52,000	65,000	17
		0.250-0.749	—	57,000	72,000	16
		0.750-1.499	—	60,000	80,000	14
		1.500 and over[3]	—	60,000	80,000	14
61S	0	All	0.098	8,000	17,000	25
	T4	All	—	21,000	32,000	22
	T6	All	—	40,000	44,000	13
	T62	All	—	30,000	40,000	20
63S	T42	0.500 and less	0.098	13,000	22,000	20
	T5	0.500 and less	—	21,000	27,000	12
	T6	0.124 and less	—	31,000	35,000	11
		0.125-0.500	—	31,000	35,000	13
75S	0	All	0.101	20,000	35,000	15
	T6	0.249 and less	—	81,000	89,000	10
		0.250-2.999	—	83,000	91,000	9
		3.000-4.499[4]	—	78,000	87,000	9

[1] *For explanation of temper designations, see booklet "Alcoa Temper Designations."*
[2] *Substantially same as –F temper.*
[3] *Maximum area 25 sq. in.*
[4] *Maximum area 20 sq. in.*

All of the commonly extruded brass have in common good hot working properties and good color, and, with the exception of Muntz metal, good machinability. Because of the ease of putting plated surfaces on brass, these alloys are often chosen for decorative applications, since the finished part is likely to be less expensive due to savings in finishing costs. Copper alloys with good hot working properties do not respond well to cold working. Since the reverse is also true, those copper alloys which do have good cold working attributes can seldom be extruded satisfactorily without subsequent cold work.

The size of brass extruded shapes is usually restricted to that which can be contained within an 8- or 8½-in. dia. circle. The effective size, therefore, would be between 6 and 7 in. across the greatest section. Length of extruded shapes is governed by the weight and, therefore, the size of the shape. Weights of single extrusions in excess of 180 lb. are seldom extruded. Taking a simple example, an extruded shape weighing 18 lb. per linear ft. could not be longer than 10 ft.

Extruded shapes can be made to greater thicknesses than drawn shapes, and can be designed with sharper corners. Radii and fillets of 1/64 to 1/32 in. are easily attained. Dimensional tolerances range from 0.005 in. on dimensions up to 0.125 in. to 0.035 in. on dimensions of 5 in. and over, in those alloys most frequently extruded.

Other than the fact that no hollow shapes can be extruded, there are few limitations on extrusions. In making channels it is usually desirable to limit the depth to a maximum of 1½ times the width of the slot, and where more than one slot is desired, the spacing between slots should be about equal to the slot width. These limitations are due to die restrictions rather than any fault of the material.

Often considerable savings can be made, particularly in regularly shaped sections, by using stock dies which are on hand in most brass mills doing commercial extruding. Standard shapes can be obtained in a wide range of sizes in such forms as angles, channels, I-beams, Z sections, open seam tubes, and round, square, hexagonal and octagonal shapes.

Extruded copper alloys can be readily brazed or soldered, and can be fusion welded, although the latter is seldom necessary. Certain alloys can be used without polishing, and plating is applied directly, without intermediate coatings.

Aluminum

Along with the growth of applications of aluminum in other forms, the use of extruded aluminum shapes is expanding rapidly. Although many users of extruded shapes in large quantities produce their own shapes, by far the larger quantity is extruded in commercial extruding plants.

The greatest growth of extruded aluminum shapes has been in the building field. Countless shapes are used in modern buildings, for structural and decorative applications. Next in importance are the structural applications in transportation equipment. Aircraft, buses and tractor trailers use the greatest number of extruded shapes. Another increasing use is for electrical bus bar in commercial buildings.

Coming up rapidly in importance are extruded aluminum shapes for use in mechanical parts and to replace assemblies and small cost and forged shapes. It would be impossible to name even a small portion of these applications. Indicative of the widespread use of aluminum shapes are the number now being used in textile equipment, where lightness and dimensional stability are much more satisfactory than the wood being replaced.

By far the most widely used aluminum alloy for extruded shapes is alloy 63S, which can be heat treated for high strength. Alloys 2S and 3S are more easily extruded, but do not possess the strength of the other extrudable alloys. For many applications where high strength is not demanded, these two alloys are used.

When greatest strength is needed in an aluminum shape, alloys 24S and 75S are chosen. These alloys are slower and more difficult to extrude. The strengths provided, though, often justify the extra expense involved in their production.

There are few limitations on the design of extruded aluminum shapes, but some difficulty in die making and maintenance might result from certain designs. For example:

Thin-walled shapes with large circumscribing circles are difficult to straighten. Stiffeners or an increase in wall thickness overcomes the difficulty.

Large overhanging die tongues create die problems. A balanced tongue is much preferred to one that is unbalanced.

It is extremely difficult to hold dimensional tolerances where extremely thin sections are joined to thick sections. In cases of this type, it is wise to limit the length of the thin section to 10 times its thickness.

Where long thin sections are placed between heavier sections, it is difficult to maintain straightness and flatness.

As far as tolerances and other design limitations are concerned, the general considerations cited in the preceding section of this manual apply.

In aluminum extruding, practice has built up a series of shape designations upon which costs are figured. Included in the standards established are three types of hollow extruded shapes. Standard terminology is explained and illustrated.

Aluminum is available in a wide range of structural shapes and sizes, including angles (both plain and bulb), channels, I sections, T, Z and W sections, tubing (both round and square), and many special shapes for specific purposes. Where such standard shapes are available die costs are eliminated.

Extruded aluminum shapes can be supplied in a variety of finishes, as extruded. A #1 finish is provided in all alloys and is used where appearance is not a factor. Where appearance is important, a #2 finish is furnished. The #2 finish is only available for certain alloys and tempers, including 2S-F, 3S-F, 63S-T42, 63S-T5, and 63S-T6. The same alloys are given a #3 finish when subsequent polishing is anticipapated. This finish is provided on solid shapes only.

Extruded shapes in aluminum are adaptable to all of the machining, joining and finishing methods applicable to other forms of wrought aluminum.

Magnesium

All wrought magnesium alloys can be provided as extruded shapes, although most extrusions are made in about five of the alloys. The properties of the alloys, at least the mechanical properties, are higher in the extruded form than in the other wrought forms, as well as better than the properties of cast forms. The extreme lightness of magnesium makes it of value in extruded form in aircraft and other transportation equipment, particularly for structural shapes. The greatest use of extruded magnesium today is in aircraft, with materials handling second and highway transportation third.

In most respects the extruding of magnesium and aluminum is similar, with the exception of the pressures needed. In certain cases, the same dies are usable for either material. Tolerances are nearly identical, as are design limitations and possibilities.

Currently certain extruded shapes in magnesium in certain alloys can compete equally on a price per foot basis with aluminum extruded shapes. In these instances, then, magnesium extruded shapes become equal to the least expensive.

One of the most interesting recent developments in magnesium extrusions is the floor section developed for truck trailers. In many respects, the shapes are similar to those used in aircraft flooring, although sections are thinner in the aircraft material.

Standard shapes and shape nomenclature are identical in magnesium and aluminum, and are explained in an accompanying illustration.

As to the magnesium alloys in which extruded shapes are made, the following are the most used:

Alloys FS and FS1 are the most widely used and can be considered as the general purpose extruding alloys. When somewhat better strength is desired, alloy J1 is usually selected. For highest strength, the heat treatable alloys ZK60A and 01 and chosen. Of these, ZK60A is most usable, since it is available in all extruded shapes. Alloy 01 cannot be extruded in hollow shapes or as tubing.

When welding is a chief requirement, alloy M is often selected, because it is the most weldable of the magnesium alloys. However, all the magnesium alloys are weldable, and probably more so than any of the other commercially extrudable materials.

As a usual practice, magnesium extrusions are given a protective oil coating. On special request, the extrusions will be given a chrome-pickle.

Other Metals

Of the other metals in which extruded shapes are to be expected, steel is making the most progress. In June of 1950 a large steel tube manufacturer announced acquisition of the right to a French process for the hot extrusion of steel. (See MATERIALS & METHODS, Mar. 1950, p. 56)

By the process, many highly alloyed steels are extruded into a variety of shapes of complex cross-section, including such shapes as the twin barrels for shot guns. Likewise, irregular tubular shapes and tubing with integral fins and ribs are being produced.

Estimates have been made that the hot extrusion process will save up to 30% in many steel shapes.

There are reports of other instances of hot extruding of steel in this country by methods which may differ from that developed in France. We hear of certain types of stainless tubing being extruded. Ford Motor Co. is reported to be extruding front wheel spindles from SAE 5132 steel. However, this is closer to impact extruding. A Texas company is reported to be extruding steel shapes in limited quantities.

Cold extruding of steel has made considerable progress during the last five years, but at present shapes are limited to cylindrical shapes such as tubes or cartridge cases.

Nickel and high nickel alloy tubing is being extruded, and recently it became known that nickel alloy T-sections are being extruded.

Many of the newer metals are being extruded, in some cases because of difficulty in machining. In most cases the problem is the same, namely, finding a die material which will withstand the heat and pressure required to extrude satisfactorily.

Common Magnesium Extrusion Alloys

Form	Alloy	Condition[1]	Mechanical Properties[2] Ult. Ten. Str., Psi.	Ten. Yld. Str., Psi.	Elong. in 2 In., %	Compression Yld. Str., Psi.
Extruded Bars, Rods, and Solid Shapes	FS, FS1	—F	37,000	26,000	12	15,000
	J1	—F	44,000	30,000	14	19,000
	M	—F	34,000	20,000	9	12,000
	O1	—F	48,000	32,000	12	—
		—T5	52,000	36,000	5	33,000
	ZK60A	—F	49,000	38,000	12	33,000
		—T5	51,000	42,000	10	34,000
Extruded Hollow Shapes	FS, FS1	—F	35,000	23,000	12	15,000
	J1	—F	41,000	24,000	13	16,000
	M	—F	32,000	20,000	8	10,000
	ZK60A	—F	46,000	34,000	11	24,000
		—T5	52,000	44,000	9	30,000

[1] *–F = As fabricated. –T5 = Aged.*
[2] *Properties given are typical.*

How Special Extruded Shapes Are Used

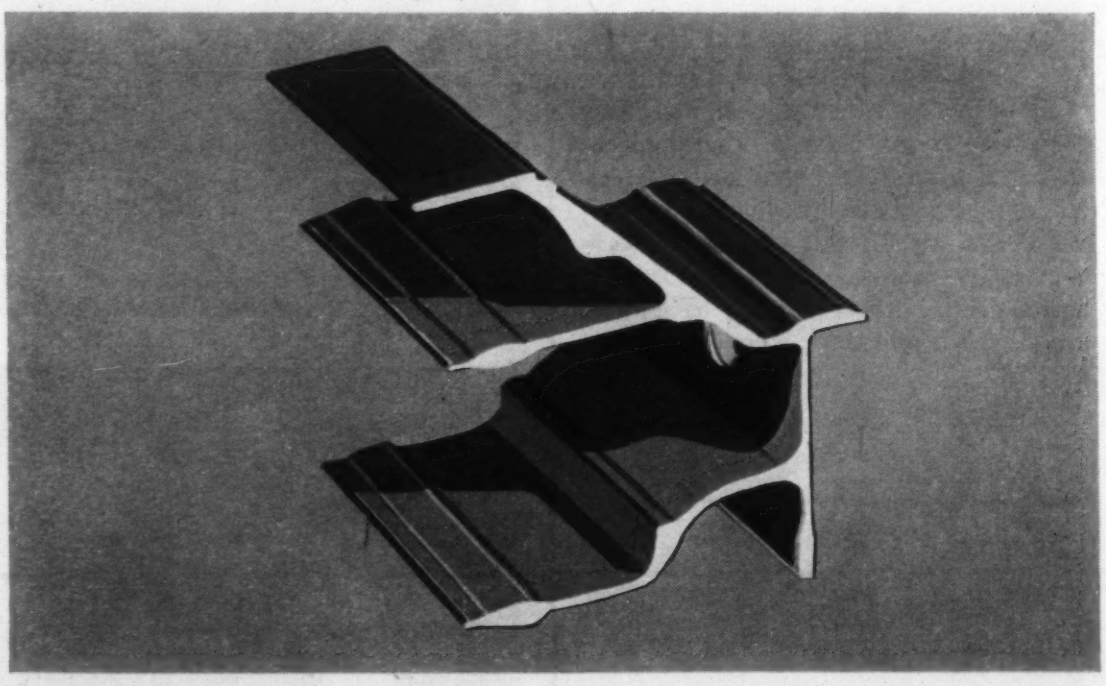
On the preceding pages we have given many of the features of extruded shapes, as well as information on their limitations and materials of which they are made. While suggestions have been made as to how extruded shapes replaced other metal forms, it will probably be of interest and value to see specific examples of how and where special extruded shapes have been used.

By the nature of the business, it is seldom possible to cite dollars and cents savings in using extruded shapes. In most cases shown here, such is not necessary, for the savings realized are almost obvious.

In selecting the examples shown here, no attempt has been made to cover all situations, for this would have been impossible. We have only selected enough examples to stimulate the imaginations of engineers and make them consider the use of extruded shapes in their products.

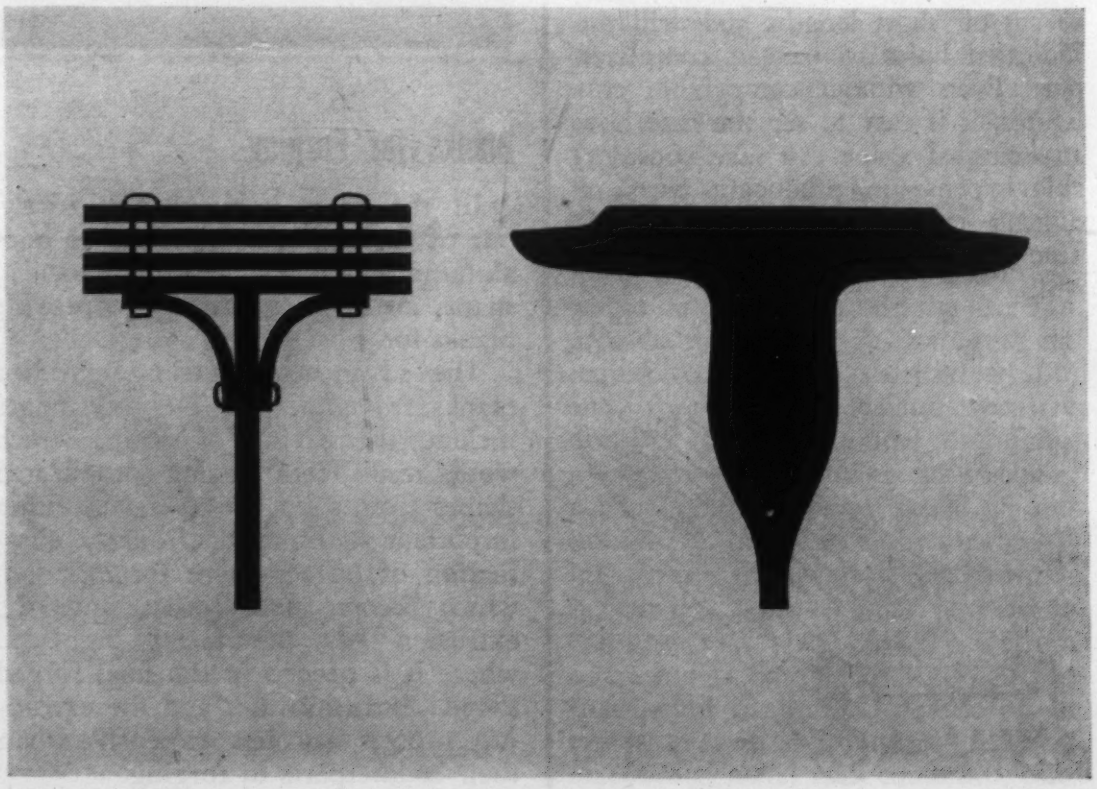
Camera Framework

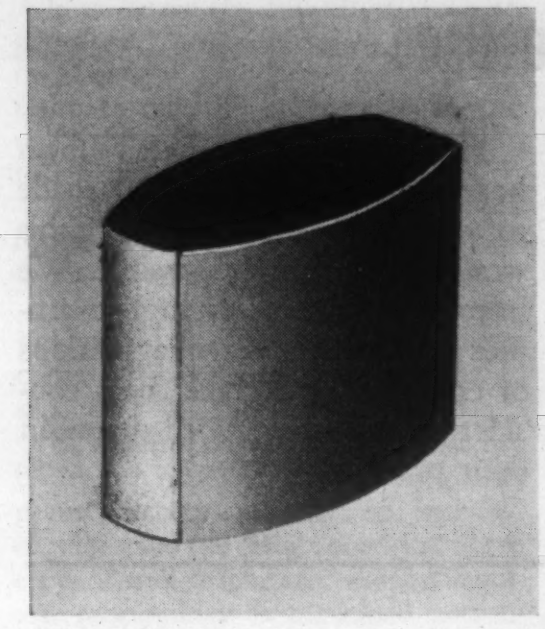
Here is an interesting example of how far one's imagination can go in the use of extruded shapes. The parts shown is the internal structural framework of a reflex camera that is extruded as a single piece. The part is completed by cutting a lens opening, drilling a few holes and enameling. The shape is the basis for the Spartus Full-Vue camera.



Wing Spar Cap

Initially, wing spar caps for aircraft were made by building up the proper thickness by joining together several sheets of aluminum or magnesium and then adding other parts to attain the proper strength and shape. Now the form is produced much more accurately, speedily and less expensively than formerly by using an extruded and cut shape. Before and after drawings are shown. This shape is only one of many extruded shapes used in aircraft wings.



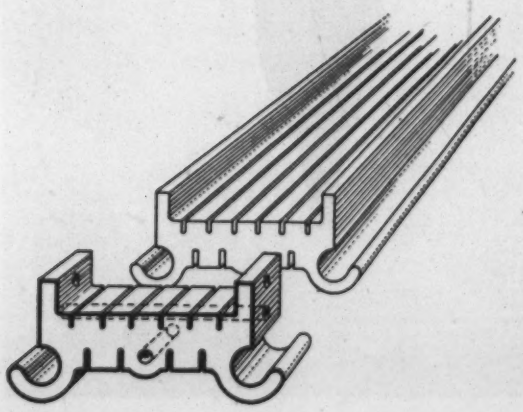


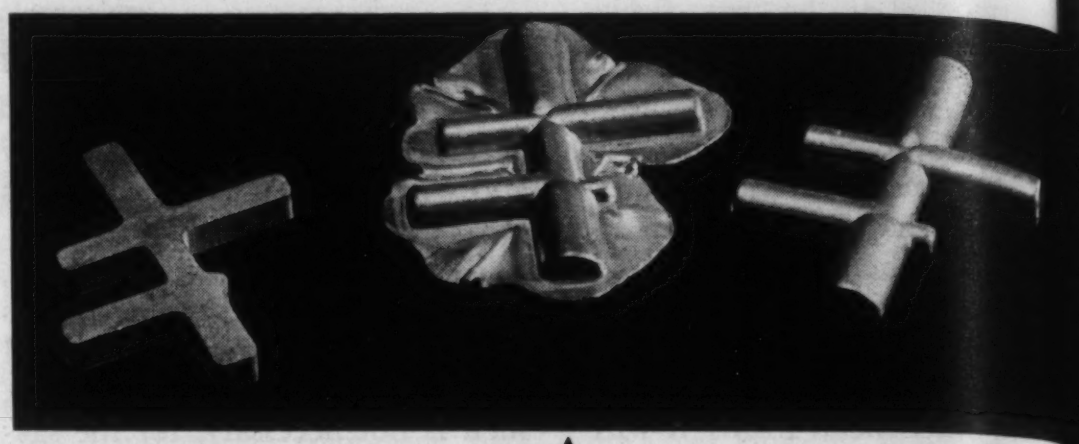
Padlock Body

Here is a simple, traditional padlock body which has been produced as an extruded shape. Most shapes of a similar type had been made as castings, with the usual number of rejects caused by internal porosity. Drilling and polishing, after cutting to length, are all that are needed to complete the part.

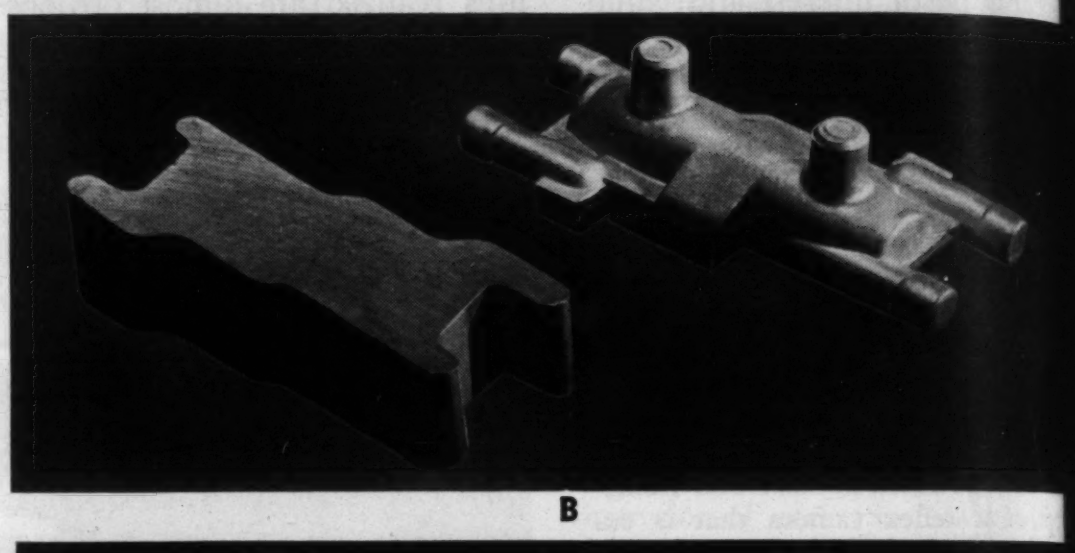
Loom Part

No matter what other method were used to produce the basic form of this loom part, considerable machining would have been required. By extruding the shape, it is merely necessary to cut off short lengths and drill the indicated holes to have a completed part. Even without comparable cost figures, it is easy to see the case how an extruded shape can save considerable expense in producing parts of difficult cross-section. Pieces of this kind can be produced up to 8 or 9 in. wide.

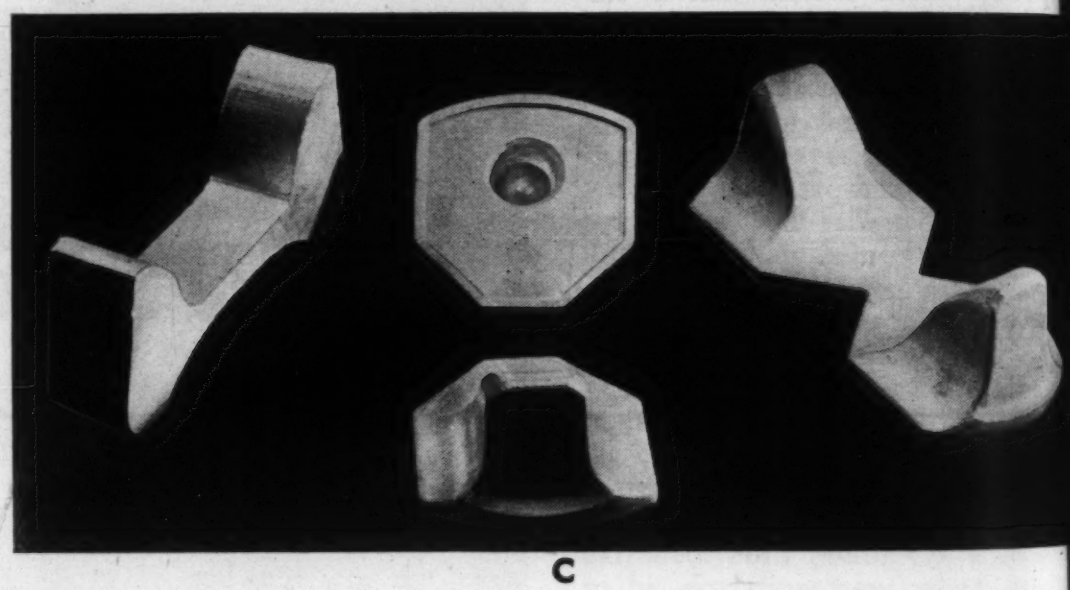




A



B



C

Blanks for Forging

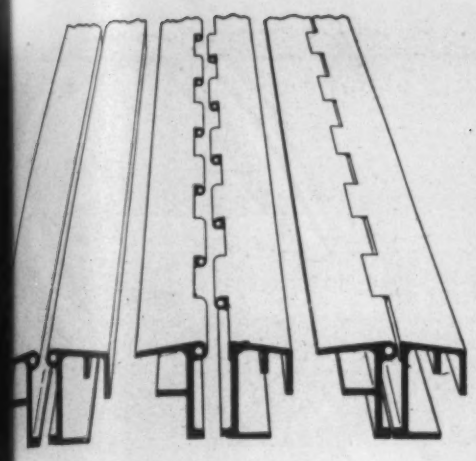
In the brass industry particularly, but of increasing importance in both aluminum and magnesium, extruded shapes are used extensively to provide blanks for subsequent forging.

The advantages of using extruded blanks are numerous. The advantages include the saving of scrap, which would result from forging complicated shapes from solid bar or rod. Another important saving results from the elimination of one or more forging dies, which become unnecessary, since the extrusion has the metal preplaced where it is needed in the final forged shape. Extrusion dies and the extruding process are less expensive than their counterparts in forging.

Illustration A shows a small br fitting in three stages of developme First is seen the extruded and c shape, which provides the blank; ne is the forged part as it comes fr the die; and finally, the complet shape with flash trimmed away.

The next illustration (B) shows heavy brass blank used for forging t gether, with the final shape forg from it. The preplacement of me is readily seen. Drilling and tappi the part will complete it.

A third example (C) shows t making of two parts from one forgi First we see the blank and then at t extreme right the forged shape pr duced from it. In the center are t two finished parts made by cutting t forging in half.

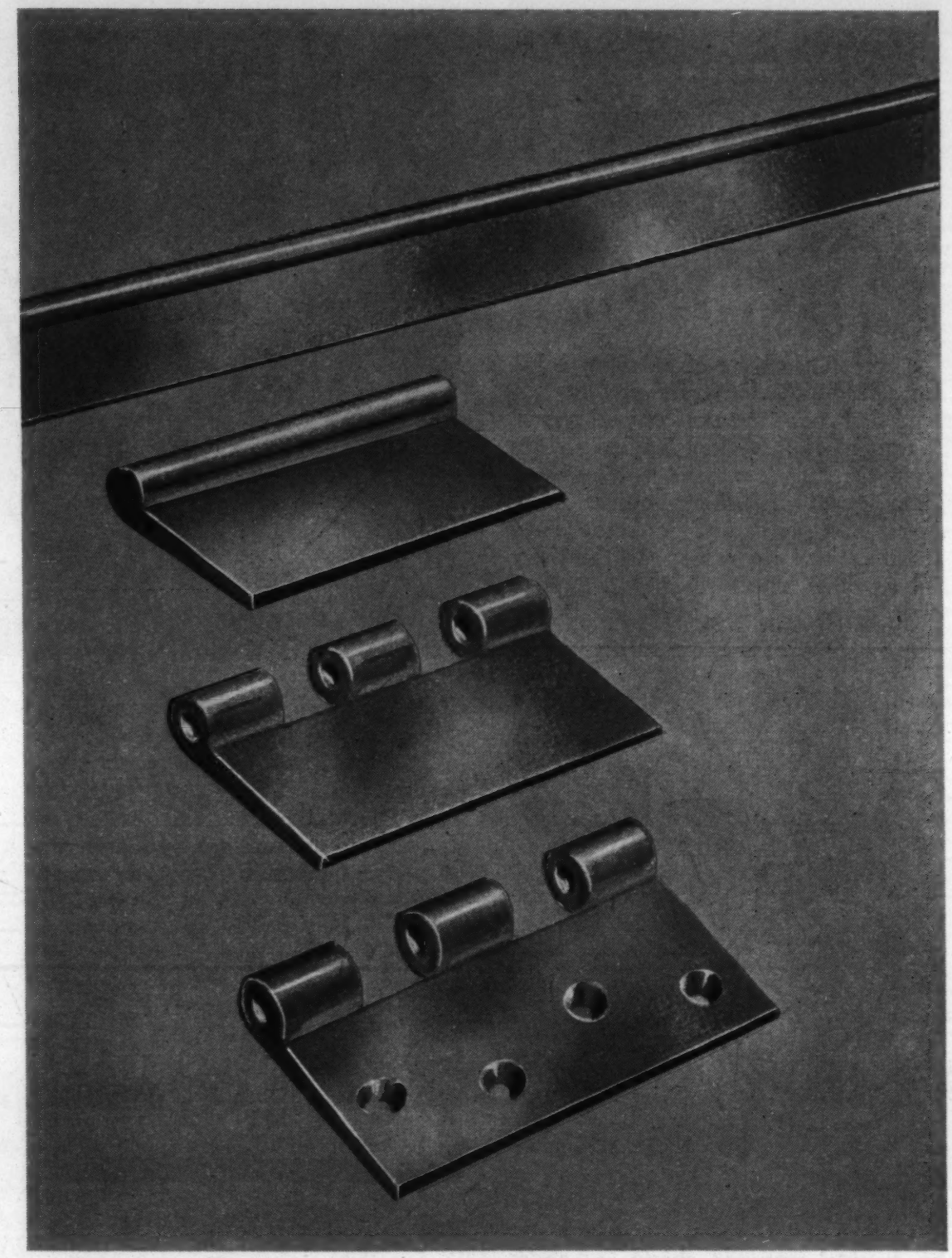


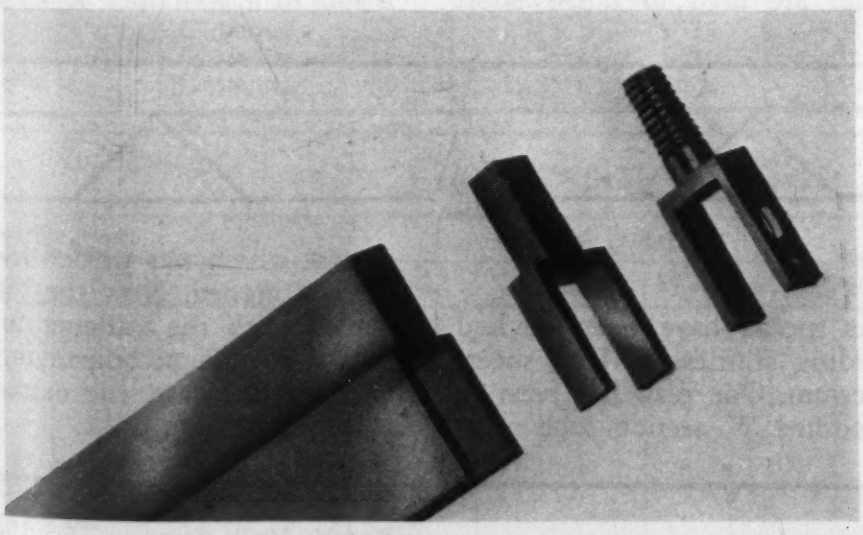
ges and Hinge Sections

Aluminum, magnesium and brass ges are all being made from ex- ded shapes. There are several types design, but the two shown here will icate capabilities of the process.

The extruded brass shape illustrated ves to make both halves of butt ges. From long mill lengths, the ruded shape is first cut into blanks required size; next, slots are milled pin holes drilled in the knuckles; ally, the leaves are drilled and coun- sunk for screw holes.

In aircraft design, extruded hinge ions are often used. The steps wn here show a typical set of ex- ded shapes for hinge sections, the ruded shapes as machined and, final- the completed assembly.

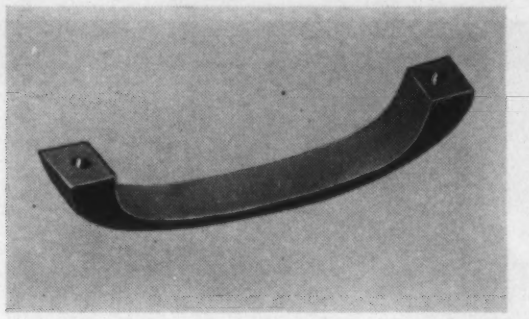




Yoke

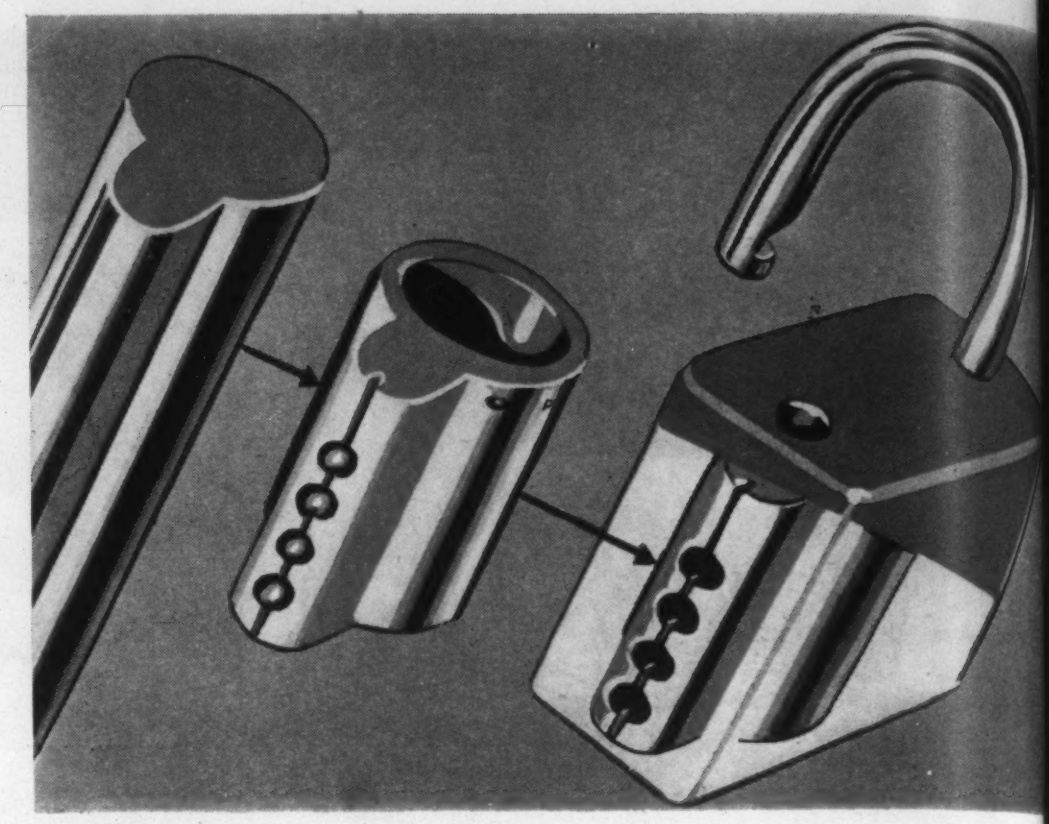
This part does not look too difficult to make, but if it were to be made from bar stock, considerable machining would be required to mill the flats and provide the groove. A casting would require considerable machining also, and a forging would demand expensive dies. All then require final machining.

However, by starting as an inexpensive extruded shape, sawed off sections are immediately ready for threading, drilling and slotting. (In this particular instance the brass yoke for a ball-float valve had been made from a casting.) Compared with milling from solid bar stock, the use of an extrusion saves approximately 40% in machining, metal and, combined, cost.



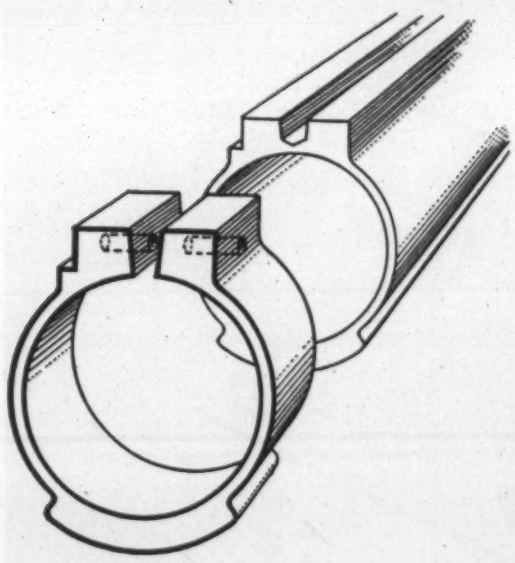
Drawer Pull

Cabinet hardware of all types is being produced inexpensively of extruded shapes. The drawer pull shown here is typical. Desired lengths are cut from the long piece. In many cases a buffing and polishing operation is given the piece, and in some cases sharp corners are broken. In the piece shown here two drilled and tapped holes make the piece ready for use.



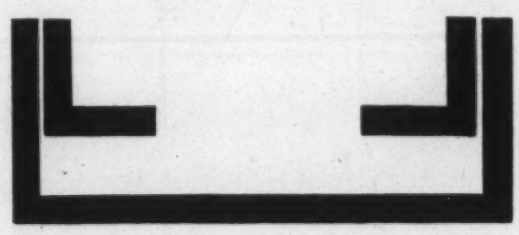
Padlock Sleeve

Padlocks have traditionally been made of brass. For many years, the bodies and some other parts were made as forgings or castings and then machined to final shape. Now, these same parts—many of them are produced as extruded shapes. Here are shown the steps in producing a padlock sle from an extruded shape. A few sim machining operations complete part. The net result is a better lo produced faster and at lower cost. T lock is made by E. T. Fraimlock C from a brass extrusion that had be produced by The American Br Co.



Clamp

Clamps of various kinds can be made by cutting extruded shapes to short lengths. In the example shown, the shape is extruded as a closed shape and opened by a simple machining operation. Drilling and tapping of two holes complete the part. In the case of brass, the shape would probably have been extruded with the throat opened much more widely than the part required. After being cut to length, the throat is pushed closed. Typical is an aluminum irrigation tubing clamp, having a 6¼-in. dia.



Rail

In this case one extruded shape takes the place of several rolled shapes that formerly were welded together. The pieces are used in rather short sections; therefore, there was cons erable expense involved in assemb Now, the desired length is merely from a long extrusion. The part sho is used by Brooks & Perkins, Inc., a rail in a container it manufactu

Stiffener

Various means have been devised for providing stiffness in long sheets of magnesium. One plan has been to use a modified W section such as is shown, which was welded to the pi being stiffened. Now the sheet is truded with the stiffener integral, shown in the accompanying illus tion. In this case, the extruded st is only 0.040 in. thick.

Acknowledgment

We wish to express our sincere thanks for the cooperation in the preparation of this manual to the following organizations.

Aluminum Co. of America
The American Brass Co.
Ampco Metal, Inc.
Bristol Brass Corp.
Brooks & Perkins, Inc.
Dow Chemical Co.
Hydropress, Inc.
Precision Extrusions Co.
Reynolds Metals Co.
Revere Copper & Brass Co.
Titan Metal Manufacturing Co.
White Metal Rolling & Stamping Co.

Materials Engineering File Facts

NUMBER 196
August, 1950

Precision Investment Steel Casting Alloys

To aid in the selection of the proper alloys for precision investment castings, one of the leading companies in the field has compiled the data on this and the next page. All values are typical, but are not guaranteed.

Alloy Steels

S.A.E. No.	Heat Treatment				Physical Properties			
	Anneal, F	Normal, F	Quench, F	Temper, F	Sp. Gr.	Ther. Exp., /F	A_1 Temp., F	A_3 Temp., F
1010	1650	1625	—	—	7.865	7.0×10^{-6}	—	—
1020	1600	1675	1600	300-1400	7.800	6.5×10^{-6}	1300	1470
1095	1500	1525	1600	300-1200	7.835	6.2×10^{-6}	—	1325
1314	1675	1650	—	—	—	—	—	—
3120	1650	1700	1600	300-1200	—	—	1290	1470
3140	1575	1575	1500	800-1250	—	6.6×10^{-6}	1325	1355
3312	1675	1675	1475	300-1200	—	6.5×10^{-6}	1250	1340
4130	1550	1650	1575	800-1200	7.845	6.2×10^{-6}	1340	1445
4140	1550	1550	1500	400-1200	—	—	1035	1320
4615	1700	1700	1500	100-600	—	—	1275	1420
4620	1700	1700	1500	300-1300	—	—	1260	1380
52100	1425	—	1525	800-1200	7.810	7.1×10^{-6}	1350	1375
6150	1525	1675	1575	400-1200	—	—	1325	1400
8620	1700	1700	1500	200-1300	—	—	1300	1470
Nitralloy 135	1700	1800	1725	1100-1300	—	6.5×10^{-6}	—	—

Tool Steels

Identification		Heat Treatment				Rockwell Hardness		
Name	Source	Anneal, F	Normal, F	Quench, F	Temper, F	As Cast	Anneal	Quench
Air Di 150	Crucible	1650	—	1825	300-1200	C28	C21	C63
Air Kool	Crucible	1375	—	1750	350-600 800-1000	C27	C20	C60
Blue Chip	Firth Sterling	1625	—	2350	800-1200	C25	C21	C65
Grenada	Crucible	1425	1600	1450	300-600	B95	B88	C66
HR-80	Houghton & Richards	1575	—	1750	350-600 800-1000	C25	C22	C60
HR-K	Houghton & Richards	1625	—	1800	350-600 800-1000	C25	C20	C63
HR-K-2	Houghton & Richards	1625	—	1850	350-600 800-1000	C22	B96	C63
Ketos	Crucible	1425	1600	1475	325-500	B95	B93	C64
Mo-Max	Cleve. Twist Drill	1550	—	2200	1000-1150	C22	C20	C66
My-A-Chrome	Houghton & Richards	1425	1600	1650	300-800	C22	B97	C65
Nu-Die	Crucible	1575	—	1850	1000-1150	C21	B96	C49
Pressure Die No. 2	Braeburn	1575	—	1850	1000-1200	B95	B93	C53
Python	Allegheny-Ludlum	1450	1550	1500	400-1000	B95	B90	C65
Red Cut Cobalt	Vanadium-Alloys	1625	—	2225	300-1300	C28	C23	C65
R.D.S.	Carpenter	1375	1675	1525	200-800	B95	B93	C61
Solar	Carpenter	1375	1650	1550	200-700	B95	B93	C62
Special No. 11	Carpenter	1425	1600	1500	100-800	B95	B88	C66
Vega	Carpenter	1375	—	1575	200-1000	C27	B97	C62

Stainless Steels

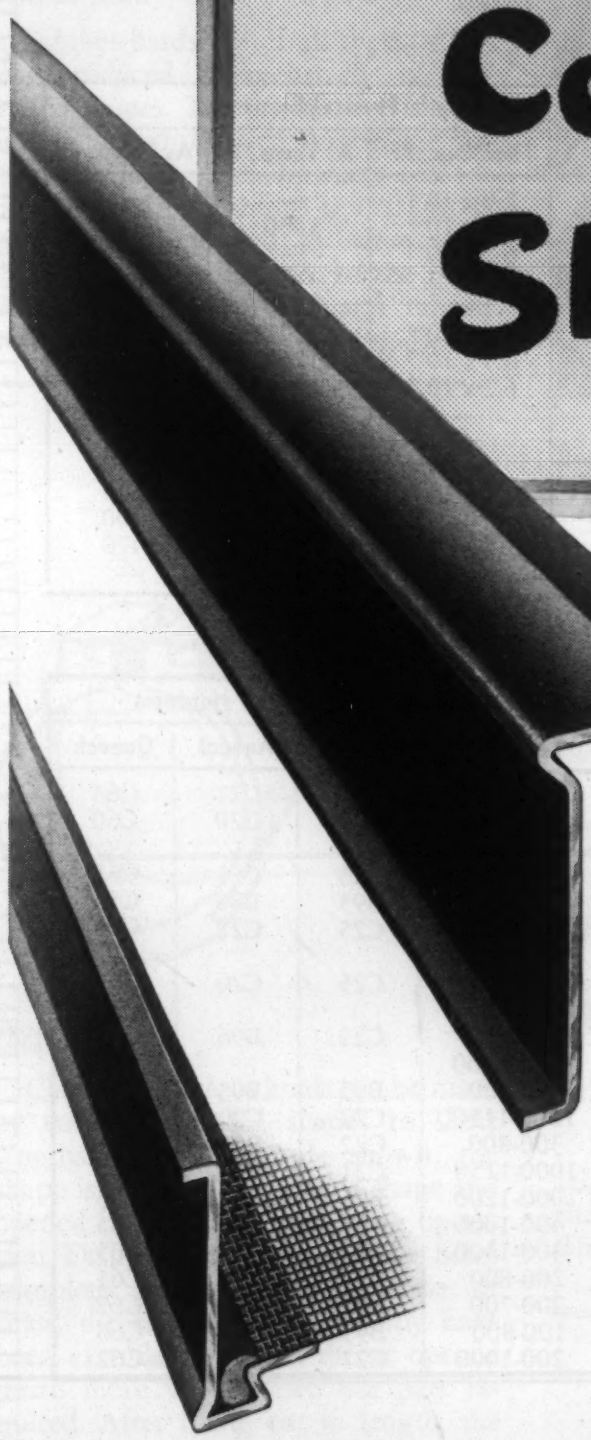
Identification		Physical Properties					Heat Treatment		
AISI Type	S.A.E. No.	Magnetic	Sp. Gr.	Ther. Cond.	Ther. Exp., /F	Mod. of Elast.	Anneal, F	Quench, F	Temper, F
304	30304	No	8.01	9.4	9.6×10^{-6}	28.0×10^{6}	2000	—	—
310	30310	No	8.01	9.4	8.0×10^{-6}	28.0×10^{6}	2025	—	—
316	30316	No	7.98	9.4	8.9×10^{-6}	28.0×10^{6}	2000	—	—
410	51410	Yes	7.86	14.4	5.5×10^{-6}	29.0×10^{6}	1575	1725	300-1200
416	51416	Yes	7.86	14.4	5.5×10^{-6}	29.0×10^{6}	1575	1775	300-1200
420	51420	Yes	7.86	14.4	5.7×10^{-6}	29.0×10^{6}	1600	1850	300-800
440C	51440C	Yes	7.86	14.0	5.6×10^{-6}	29.0×10^{6}	1575	1800	300-800
19-9 DL									
Universal-Cyclops		No	7.93	8.4	8.5×10^{-6}	29.5×10^{6}	2100	2350	1200-1500
17-4-PH ARMCO		Yes	—	—	—	—	1850	1850	600-1200

See next page for additional data on these steels.

(Continued on page 79)

FRAMES FOR WINDOW SCREENS MADE FROM

Cold-Formed Shapes



The cold-formed shape shown above is used as a stu window-screen frame by a manufacturer of sash and windo We make it on rolling machines, using 20-gage strip st and furnish it in 20-ft lengths.

Frames for window screens are but one of hundreds uses that manufacturers have found for Bethlehem C Formed Shapes. You'll find these versatile, economical sha being used by makers of such widely-diversified items ornamental railings, seamless milk cans, storage ra freight elevator doors, and highway trailers. New uses being discovered almost every day.

Bethlehem Cold-Formed Shapes are made in all leng from strip, sheet or plate steel. They are uniform in thickn and have an excellent strength-to-weight ratio. In addit their smooth surface is relatively free from scale. They c in gages from 7 to 24, inclusive — a range sufficiently w to meet virtually every need.

It's possible that somewhere in your manufacturing op tions Bethlehem Cold-Formed Shapes could be used to q advantage. Let a Bethlehem man look into it for you! Ph or write to us at Bethlehem, Pa.

BETHLEHEM STEEL

BETHLEHEM STEEL COMPANY, BETHLEHEM, P

On the Pacific Coast Bethlehem products are sold by Bethlehem Pacific Coast Steel Corporation. *Export Distributor:* Bethlehem Steel Export Corporation

Materials Engineering File Facts

NUMBER 196—(Continued)

PRECISION INVESTMENT STEEL CASTING ALLOYS

Alloy Steels

S.A.E. No.	Mechanical Properties: Annealed Yield	Ult.	Elon.	R.A.	BHN	Heat Treated (Max.) Yield	Ult.	Elon.	R.A.	BHN	As Cast BHN	Machinability
1010	35,000	60,000	30	60	116	—	—	—	—	—	120	50
1016	—	—	—	—	—	—	—	—	—	—	130	50
1020	40,000	60,000	35	65	130	48,000	78,000	12	25	150	135	53
1095	65,000	127,000	5	5	250	—	—	—	—	500	260	30
1314	—	—	—	—	—	—	—	—	—	—	—	90
3120	—	—	—	—	—	—	—	—	—	415	—	53
3140	64,000	96,000	26	56	197	230,000	270,000	5	27	575	205	32
3312	75,000	90,000	28	62	185	180,000	220,000	12	55	375	195	50
4130	60,000	89,000	32	65	190	—	—	—	—	515	220	55
4140	63,000	90,000	19	33	190	230,000	265,000	8	35	575	225	50
4340	69,000	100,000	20	45	200	245,000	290,000	10	40	590	230	65
4615	48,000	78,000	33	65	140	85,000	135,000	23	35	275	160	51
4620	46,000	78,000	25	50	150	155,000	195,000	16	47	320	165	51
52100	81,000	100,000	25	57	195	227,000	240,000	5	30	685	210	30
6150	58,000	91,000	22	53	185	270,000	310,000	7	19	610	200	40
8620	65,000	93,000	25	65	190	110,000	145,000	16	48	415	205	60
Nitralloy 135	85,000	110,000	30	65	190	155,000	180,000	12	45	400	200	—

Tool Steels

Identification	General Characteristics: Non-deforming	Safety in Harden.	Toughness	Resist. to Soften.	Wear Rest.	Machinability	Quench Medium	Depth of Harden.	Resist. to Decarb.
Air Di 150	Good	Good	Poor	Fair	Best	Poor	Air	Deep	Fair
Air Kool	Best	Best	Fair	Fair	Good	Fair	Air	Deep	Fair
Blue Chip	Good	Good	Poor	Good	Good	Fair	Oil, air brine	Deep	Good
Grenada	Poor	Fair	Good	Poor	Fair	Best	Water	Shallow	Best
HR-80	Best	Best	Fair	Fair	Good	Fair	Air	Deep	Good
HR-K	Good	Good	Poor	Fair	Best	Poor	Oil	Deep	Fair
HR-K-2	Best	Best	Poor	Fair	Best	Poor	Air	Deep	Fair
Ketos	Good	Good	Fair	Poor	Good	Good	Oil	Medium	Good
Mo-Max	Good	Fair	Poor	Good	Good	Fair	Oil, air brine	Deep	Fair
My-A-Chrome	Poor	Fair	Best	Fair	Fair	Fair	Oil, water	Medium	Poor
Nu-Die	Good	Good	Good	Good	Fair	Fair	Air	Deep	Fair
Pressure Die No. 2	Good	Good	Good	Good	Fair	Fair	Air	Deep	Fair
Python	Poor	Fair	Good	Poor	Good	Best	Water	Shallow	Best
Red Cut Cobalt	Good	Fair	Poor	Best	Good	Fair	Oil	Deep	Poor
R.D.S.	Good	Good	Good	Fair	Fair	Fair	Oil	Medium	Fair
Solar	Poor	Poor	Best	Fair	Fair	Fair	Oil, water	Medium	Poor
Special No. 11	Poor	Fair	Good	Poor	Fair	Best	Water	Shallow	Best
Vega	Best	Best	Fair	Fair	Good	Fair	Air	Deep	Good

Stainless Steels

Identification: AISI Type	S.A.E. No.	Mechanical Properties: As Cast Rock. Hard.	Annealed Yield	Ult.	Elon.	R.A.	Izod Impact	Rock. Hard.	Max. Rock. Hard.	Scaling Temp., F: Continuous	Intermittent
303	30303F	B-85	35,000	90,000	50	55	80	B-84	—	1600	1450
304	30304	B-85	35,000	85,000	60	70	110	B-81	—	1600	1450
310	30310	B-85	40,000	85,000	55	60	100	B-81	—	2000	1900
316	30316	B-85	35,000	85,000	60	70	110	B-81	—	1650	1500
410	51410	B-85	40,000	75,000	35	70	90	B-82	C-41	1250	1400
416	51416	B-90	40,000	75,000	30	60	70	B-82	C-41	1250	1400
420	51420	B-98	50,000	90,000	28	59	—	B-93	C-53	1250	1400
440C	51440C	B-95	65,000	110,000	15	30	—	B-97	C-59	1200	1400
19-9-DL											
Universal-Cyclops		C-25	66,000	118,000	55	55	—	B-85	C-30	—	—
17-4-PH ARMCO		C-40	100,000	135,000	10	50	35	C-30	C-45	—	—

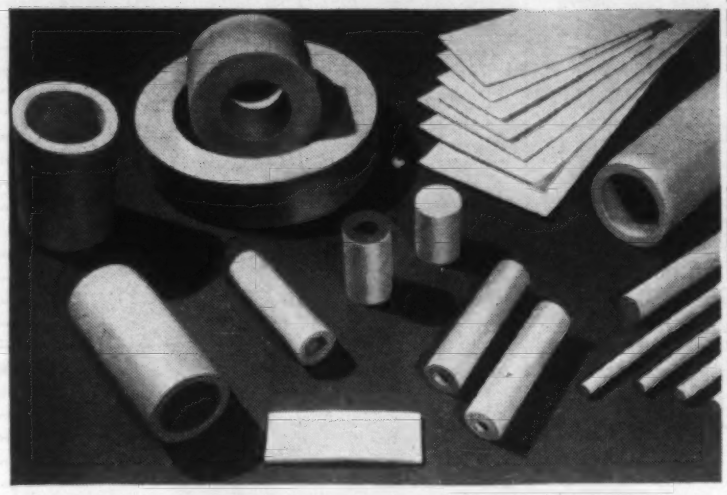
Courtesy Precision Metalsmiths, Inc.

TEFLON *and United States Gasket*

(SEE OPPOSITE PAGE)

Solve Many Materials Problem

Teflon Stock and Fabricated Teflon Parts In Experimental or Production Quantities



Sheets • Cylinders • Rods • Tubing • Bars

We manufacture and supply, for immediate delivery in any quantity, the most complete range of Teflon stock shapes and sizes anywhere obtainable. For example, we furnish *unoriented* Teflon sheets in thicknesses from 1/16 in. up and in sizes 36 x 36 in. as well as the regular 24 x 24 in. size.

From our Teflon stock you can machine or otherwise form experimental parts or units. In cases where standard sizes and shapes of stock Teflon are found unsuitable for economical production of machined parts or units, we will mold special shapes or produce variations of stock sizes to suit your needs. If desired, we will supply finished molded or machined parts exactly to your specifications.

Write for complete information on shapes and sizes available or send us your specifications for quotation.

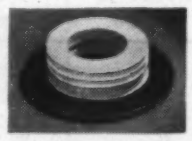
Because no acid, caustic or solvent can attack Teflon, its u as a gasketing and packing material was immediately obvio

United States Gasket Company was one of t first and has remained the foremost fabrica and supplier of Teflon gaskets and packing solid, jacketed, impregnated, molded, machin and combined with metals and other materials.

Next came uses in which Teflon's marked resistance to a hesion was the principal reason for its selection. Bakery r

molded of Teflon by USG greatly reduced t sticking of dough, cut bread-making costs a produced a finer product. Many other appli tions of Teflon rollers are currently in use a under test—ink rollers, for one example. Teflon rollers re sticking, withstand high temperature, cannot be wetted, chemically inert, and can be quickly and easily cleaned.

In scores of industries, materials men are finding Teflo unusual combination of valuable properties the long-sou answer to problems previously unsolved. Teflon expansion joi



for corrosion-proof piping systems, Teflon d phragms, valve discs, pump cups, thermome wells, bellows adaptors, pump impellers, be ings, stopcocks, guide and work surfaces, vess nozzles, and Teflon insulators or parts for high frequency e trical equipment—these are but a few of the successful appli tions of Teflon created or fabricated by USG.

In a number of instances, the Teflon has been impregna or combined with other materials (glass, carbon, copper, e to provide specific chemical and physical characteristics.

We cannot disclose, we do not even know, many of the u to which our customers are putting the Teflon units we fabric for them. But we like the fact that small trial orders are usu followed by larger repeat orders.

We have the equipment and the experience for fabricat Teflon in every way thus far proved practical (except w coating) and are constantly experimenting to develop perfect new fabrication techniques.

For Teflon Stock or Fabricated Units . . .

Teflon Products Division

UNITED STATES GASKET COMPAN

656 North 10th Street • Camden, New Jers

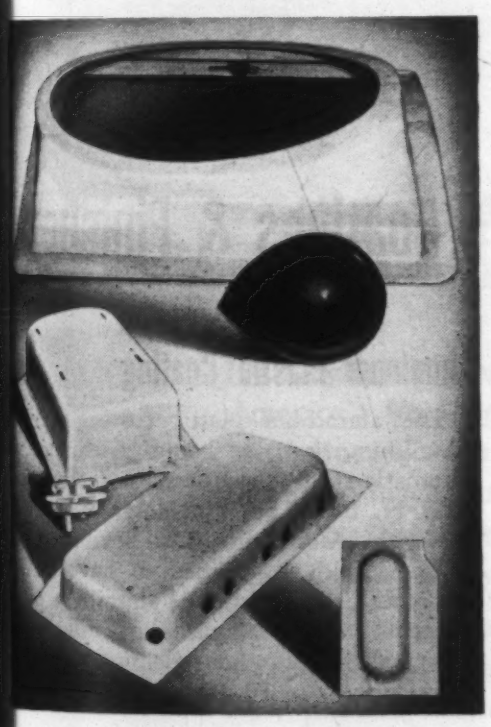
New Materials and Equipment

Materials

Laminating Material

A new ready-to-form laminating material with a high tensile and flexural strength has been introduced by *Flexfirm Products,* of El Monte, Calif.

Trade-marked Dryply, it consists of glass cloth or mat impregnated with a complete polyester compound, including catalyst,



Finished Dryply parts, shown here as used in various industries, have replaced metal parts in many instances.

which comes to the manufacturer in a dry state, ready to use.

Dryply laminates are claimed to be dimensionally stable and contain no volatile ingredients or plasticizers, allowing them to be formed to any shape or size while retaining their exact tolerance. Solvents, acids and alkalies have little or no effect on this material, while its water absorption and moisture permeability are low.

Manufactured in rolls, the material can be compared with phenolic laminates in ease of handling. In use, it is simply trimmed, laid up for forming, and heat-cured by conventional methods.

Vinyl Insulating Compound

A new vinyl insulating compound, designed especially for high temperature service, has been developed by the *B. F. Goodrich Chemical Co.,* 324 Rose Bldg., Cleveland 15.

Known as Geon Plastic 8630, the compound withstands oils and most chemicals at higher temperatures and for longer periods than rubber. Advantages claimed for the compound, which make it a satisfactory insulation material for thermocouple lead wires and other similar applications, include resistance to high temperature aging, abrasion and deformation resistance, and flexibility at both high and low temperatures.

Geon 8630 has been found to be non-corrosive toward copper, does not affect painted or varnish surfaces, and exhibits good weathering characteristics. Its high dielectric strength permits thinner insulation walls than are possible with other insulating materials.

In addition, it has received Underwriters' Laboratories' approval for use as electrical tubing at 221 F and for use as appliance wiring insulation at 194 and 221 F.

Special Stainless Steel

A new alloy, Armco 430 ELC Stainless Steel, has been developed by the *Armco Steel Corp.,* of Middletown, Ohio, for use in television viewing tubes.

So that continuous thermal contraction of about the same rate as glass could be obtained during cooling, it was once necessary to use either 28% chromium steel or 17% chromium steel with special stabilizing elements. However, by reducing the carbon content of the new alloy to below 0.03%, the manufacturer has produced a metal which meets the cooling requirements without the aid of expensive stabilizing elements.

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Parts & Forms

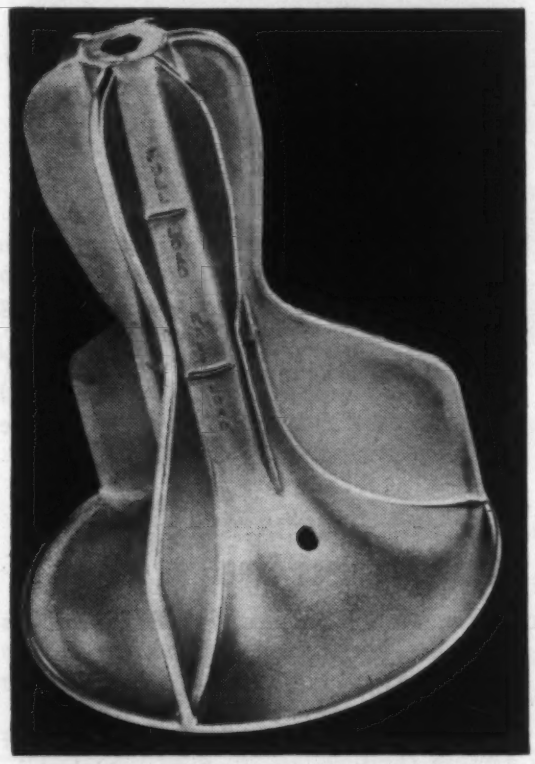
Aluminum Casting Process

A process which is claimed to produce brighter, smoother and more durable aluminum permanent mold castings has been developed by *Monarch Aluminum Manufac-*

New Materials and Equipment
(CONTINUED)

turing Co., 9301 Detroit Ave., Cleveland.

Called "Velvaglaze," the process provides a denser surface through its ability to seal the pores of the casting and increase the wearing qualities. Initial tests are said to indicate that the new process retards, and in some cases, resists corrosive action to a degree not possible in the ordinary commercial aluminum casting.



This aluminum washing machine agitator, produced by the "Velvaglaze" process, is marked by a brighter, smoother surface.

The specific properties imparted by the process to aluminum castings are said to make it particularly applicable to the agitators commonly used on automatic and wringer-type clothes washers.

Plastic Pipe

A plastic pipe which features high burst pressure and resistance to suction collapse has been developed by *Carter Products Corp.*, 10235 Meech Ave., Cleveland 5.

Designated Carlon "EX," the pipe is flexible, light in weight, and is claimed to have absolute resistance to rot, rust and electrolytic corrosion. Recommended by the manufacturer for handling liquids intended for human consumption as well as for conveying industrial processing solutions, wastes, and highly-corrosive gases and vapors, this new pipe has burst pressures up to 260 psi.

Coupled easily by means of molded plastic fittings, which permit plastic-to-plastic or plastic-to-metal connection, the pipe can be curved to follow ditches and ground contours or to conform to structural plans.

Extruded Rubber Cord

Extruded rubber cord, developed especially for use in the automotive industry to "tie" seat cushion springs, is now available from the *Stalwart Rubber Co.*, 165 Northfield Rd., Bedford, Ohio.

Characteristics of the cord are claimed to make it suitable for many applications in the aviation, refrigeration, electrical and other allied fields of manufacture. These include: (1) excellent tear resistance, (2) good resistance to flex, (3) excellent age resistance, (4) resistance to extremes of temperature, (5) abrasion resistance, and (6) chemical resistance.

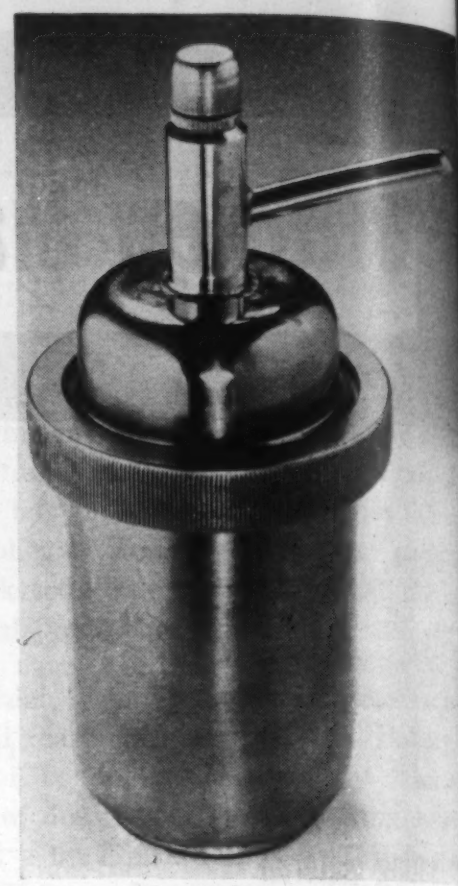
Stainless Tube

Carpenter Stainless No. 10, an alloy which work-hardens more slowly than conventional chromium-nickel steels, is now available in tubing form. Manufactured by the *Alloy Tube Div.* of *Carpenter Steel Co.*, Union, N. J., the tubing is suitable for applications requiring severe forming, bending, upsetting, spinning, coining or extruding. The properties of this steel were described earlier in MATERIALS & METHODS (Feb. 1950, p. 59).

Corrosion resistance of No. 10 is claimed to be slightly better than that of Types 304 and 305. In addition, this tubing has been found useful for parts that must remain nonmagnetic after severe cold working.

Round tubes are available in all sizes and standard gages up to 1⅜ in. O.D. and shapes whose equivalent round will not exceed that diameter. Special rollings requiring at least 2000 lb. would be required for larger sizes.

The developers believe this tubing will make possible products and parts heretofore



Carpenter Stainless No. 10 tubing could b used to fabricate products such as this hig pressure container and dispenser.

impossible to fabricate from stainless tubing and will lower production costs on severely formed items now being made from 18-8 stainless steels.

Coatings & Finishes

Aluminum Plastic Coating

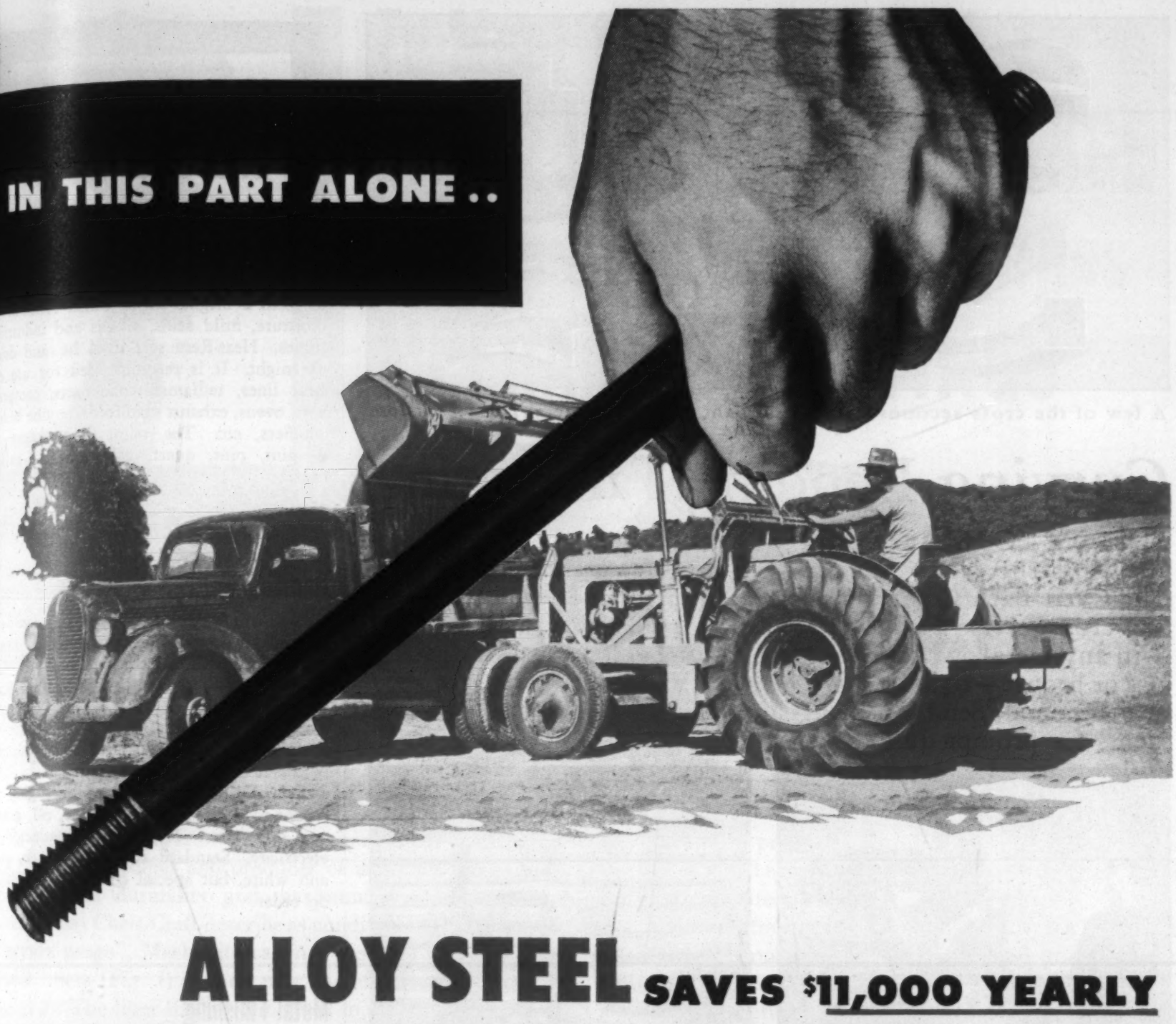
The aluminum plastic coating, Krylon Aluminum, is now being distributed in automatic spray dispensers by *Krylon, Inc.*, 2601 N. Broad St., Philadelphia 32.

Krylon Aluminum is a flexible plastic coating which is claimed to have all the favorable characteristics of aluminum paint. It resists moisture, light acids, dilute alcohols and many other chemicals, and requires only 5 to 10 min. to dry.

Heat Resistant Paint

Improvement in the lustre, water repellence and coverage of Heat-Rem aluminum paint as a result of a silicone addition has been announced by *Speco, Inc.*, 7308 Associate Ave., Cleveland 9. This paint is intended specifically for exterior and interior metal surfaces where temperatures in the range of 1000 to 1500 F are encountered.

The paint is said to fuse with the met



ALLOY STEEL SAVES $11,000 YEARLY

It's a cylinder head stud bolt—used by one of America's leading tractor manufacturers—Minneapolis-Moline. At the suggestion of a Republic machining specialist, it was decided to switch from hot rolled steel bars to Republic Cold Drawn Alloy Steel for this part.

Results were *immediate!* Heat treating and straightening operations were eliminated . . . process savings offset higher material cost by .083¢ per piece . . . annual savings amount to $11,000.

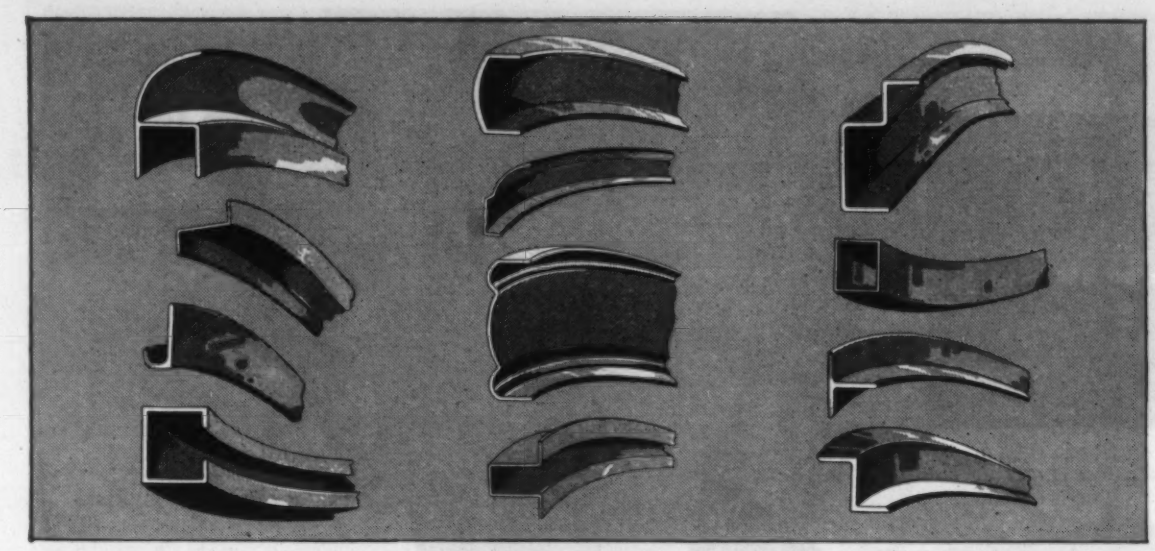
This is but one of countless applications in which Republic Alloy Steels—cold finished by Republic's Union Drawn Division—are demonstrating their ability to cut manufacturers' climbing costs.

It's one more good reason why it will pay you to give Republic Cold Finished Alloy Steel a trial in your own operations. Write for further information *today.*

REPUBLIC STEEL CORPORATION
Alloy Steel Division • Massillon, Ohio
GENERAL OFFICES • CLEVELAND 1, OHIO
Export Department: Chrysler Building, New York 17, N.Y.

Republic COLD DRAWN
REPUBLIC STEEL
ALLOY STEEL BARS

Other Republic Products include Carbon and Stainless Steels—Sheets, Strip, Plates, Pipe, Bars, Wire, Pig Iron, Bolts and Nuts, Tubing

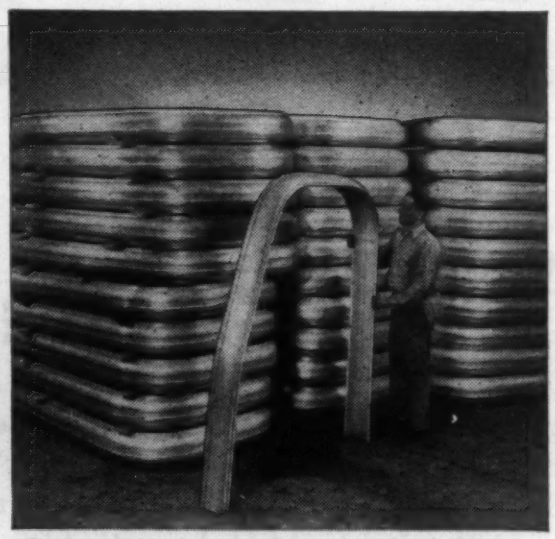


A few of the cross sections curved and bent by BATH Metal Form Division.

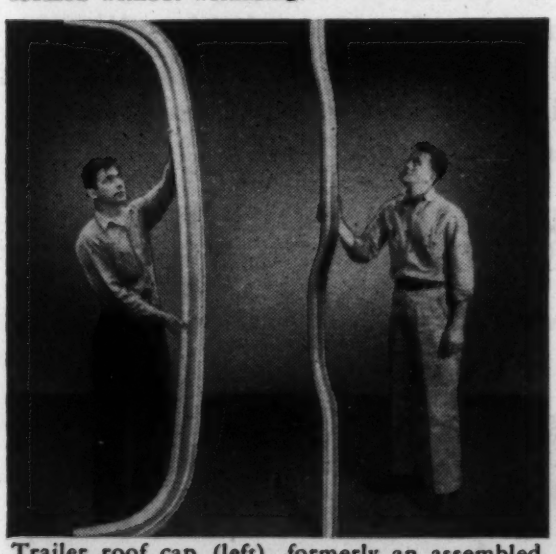
Curving, Bending, Fabricating

CUSTOM FORMING of curved parts, accurately and inexpensively, is the regular function of the Metal Form Division of The Cyril Bath Company. We curve, bend and fabricate—from any cross section, whether extrusion, rolled, bar, strip or sheet—in any metal, whether aluminum, carbon or alloy steel, stainless or bronze—to any curve, whether shallow or sharp, constant or compound. Send blueprints and estimated production requirements for prompt quotation.

Stainless channels and steel locking rings are formed without wrinkling.



Outer profile structural member formed in one piece from aluminum alloy extrusion.



Trailer roof cap (left), formerly an assembled section, is formed in one piece by BATH. Coach frame (right) includes reverse bends.

Curves not normally formable, or too costly to form on conventional equipment, are no problem for the BATH method.

The CYRIL BATH Co.

6901 MACHINERY AVE. • CLEVELAND 3, OHIO

New Materials and Equipment

to form a bright, elastic finish resistant to moisture, mild acids, alkalis and industrial fumes. Heat-Rem sets in 4 hr. and dries overnight. It is recommended for use on heat lines, radiators, condensers, compressors, ovens, exhaust manifolds, engine heads, mufflers, etc. The paint is packaged in ½-pint, pint, quart, gallon and 5-gallon cans.

Non-Slip Protective Coating

Non-slip treading surfaces on damp or dry surfaces of wood, concrete or metal (except galvanized iron) are possible with Dyna-Grip, a product announced by *Merchants Chemical Co.*, Elm Court, Stamford, Conn. The material is a formulation of selected abrasives suspended in a solution of blended thermoplastic resins.

Dyna-Grip is also said to be highly resistant to acids, alkalis, gasoline, oil, grease and salt water. It is a non-conductor of electricity. Standard colors are black, gray and white, but special colors are available on order.

Metal Finishing

A new formulating technique claimed to eliminate the problem of "solvent wash" from baking finishes used on metal parts has been announced by the *Industrial Finishes Div.* of *Standard Varnish Works*, 2600 Richmond Terrace, Staten Island 3, N. Y.

"Solvent wash" is a condition in which sharp corners and areas adjacent to edges or perforations are incompletely coated, and is believed to arise from the solvent action of the thinner in the coating and from inadequate ventilation in the finishing system.

Cleaning & Finishing

Solvent Emulsion Cleaner

Chemclean Products Corp., 64 Sixth Ave., New York 13, has developed a solvent emulsion cleaner called S.E.C., which is

To Meet the Problem of "EXTREMELY SEVERE USAGE" Chris-Craft specifies MEEHANITE® CASTINGS

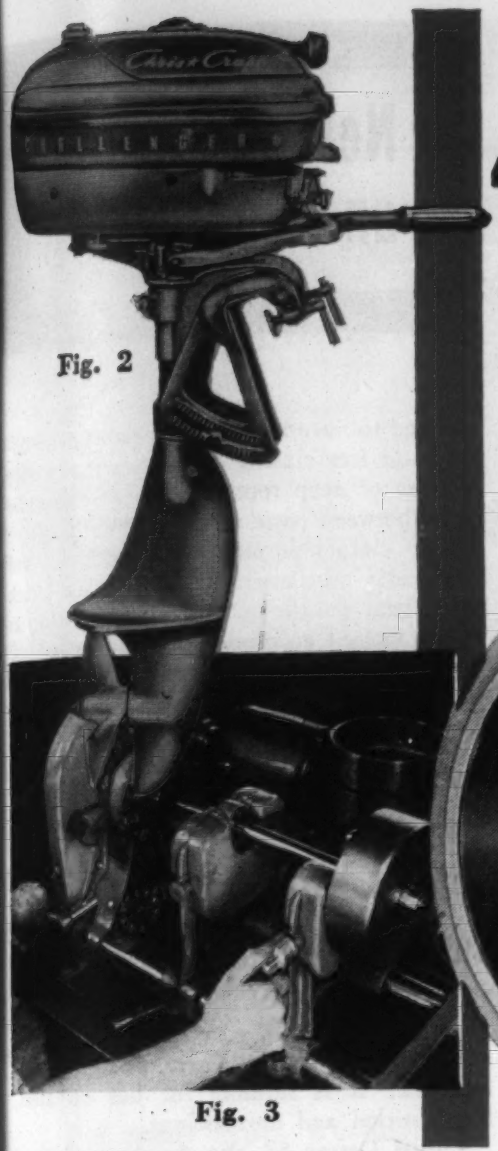


Fig. 2

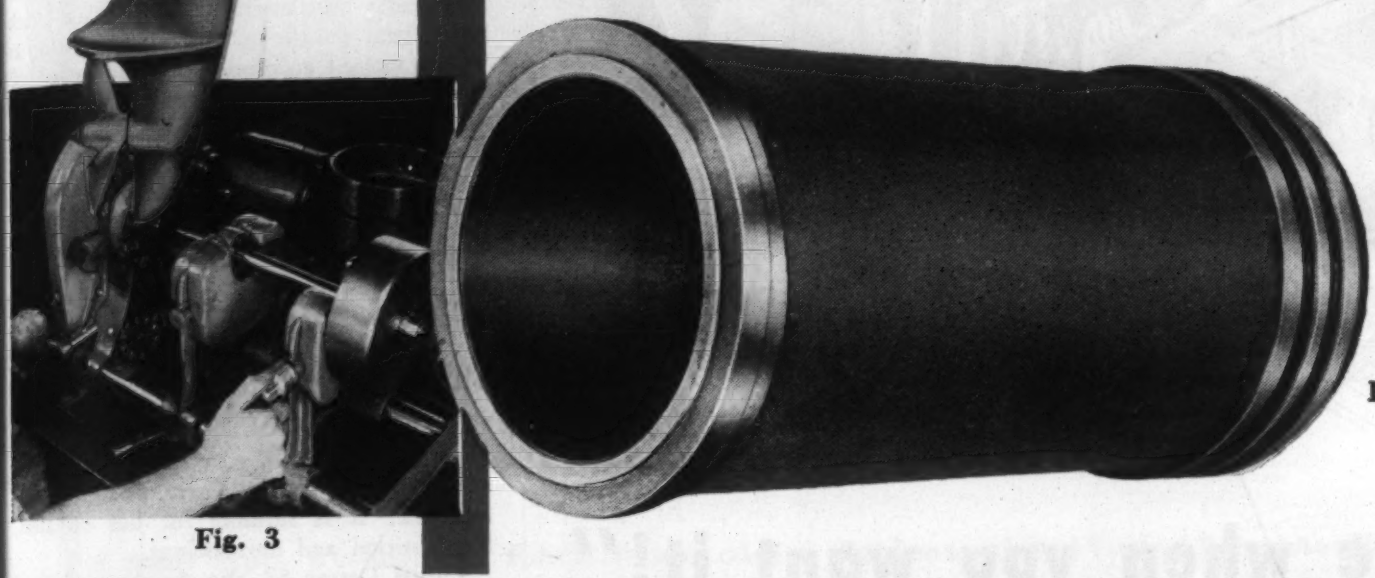


Fig. 1

Fig. 3

The problems of severe wear are an everpresent challenge to both the specifier and producer of materials. So as to provide real durability and maximum wear resistance under what Chris-Craft describe as conditions of extremely "severe usage", Meehanite castings are used for the cylinder liners (*Fig. 1*) in their new line of outboard motors (*Fig. 2*). The liner itself is subjected to precision machining and as a result must be truly flawless in every sense. Furthermore, the metal structure must provide the proper combination and constitution necessary to resist the constant high-speed rubbing action of the pistons. Because the Meehanite processes permit accurate regulation and control of metal structure these important parts are specified as Meehanite castings.

In addition, the outboard flywheel (*Fig. 3*) is a Meehanite casting which must be carefully machined to an accurate balance and also retain a truly dimensional stability.

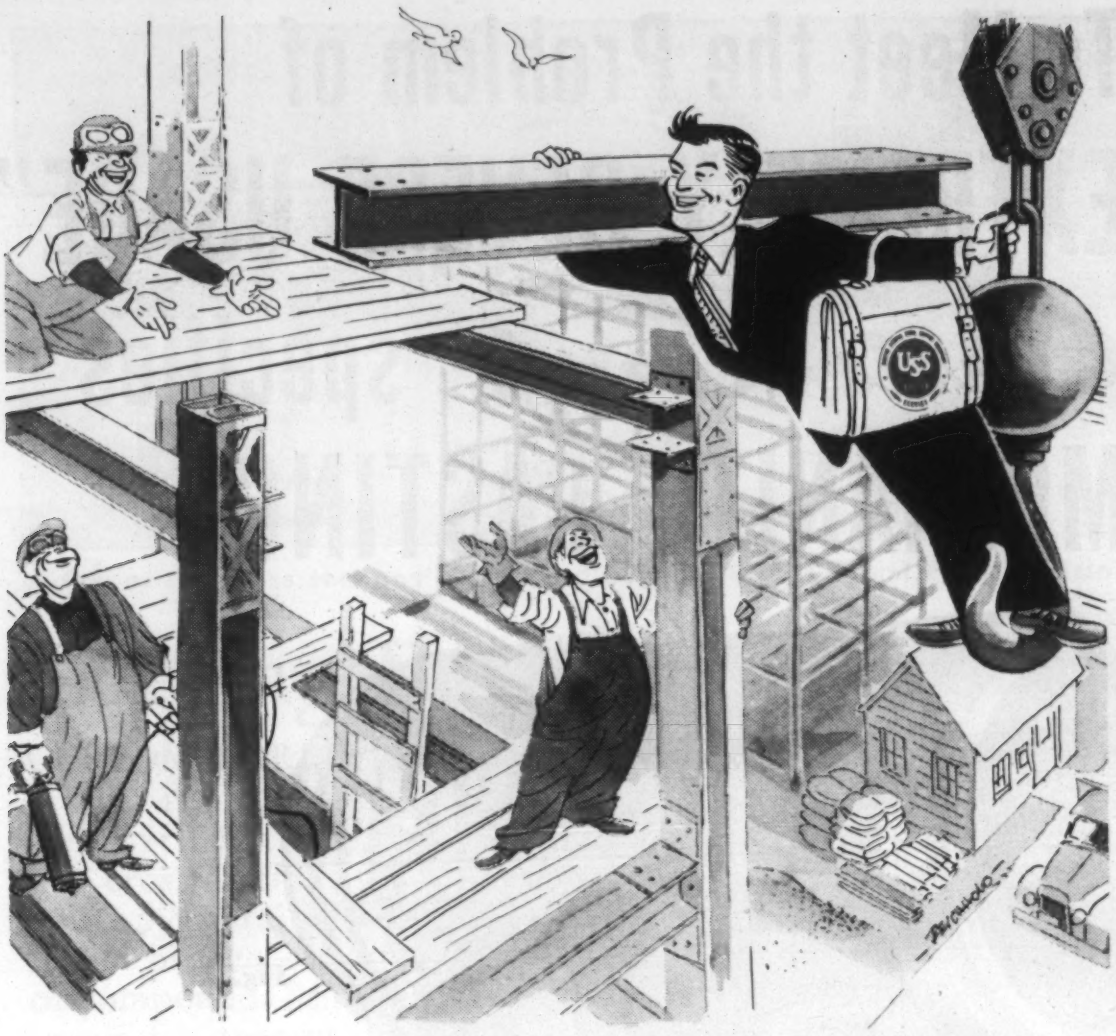
The manufacture of high-quality Meehanite castings accurately produced to provide you with the correct combination of engineering characteristics for your job is the daily function of the foundries listed below.

Take Your Casting Problems To A MEEHANITE Foundry!

American Brake Shoe Co.	Mahwah, New Jersey
The American Laundry Machinery Co.	Rochester, New York
Atlas Foundry Co.	Detroit, Michigan
Banner Iron Works	St. Louis, Missouri
Barnett Foundry & Machine Co.	Irvington, New Jersey
E. W. Bliss Co.	Hastings, Mich. and Toledo, O.
Builders Iron Foundry, Inc.	Providence, Rhode Island
Continental Gin Co.	Birmingham, Alabama
The Cooper-Bessemer Corp.	Mt. Vernon, Ohio and Grove City, Pa.
Farrel-Birmingham Co., Inc.	Ansonia, Connecticut
Florence Pipe Foundry & Machine Co.	Florence, New Jersey
Fulton Foundry & Machine Co., Inc.	Cleveland, Ohio
General Foundry & Manufacturing Co.	Flint, Michigan
Greenlee Foundry Co.	Chicago, Illinois
The Hamilton Foundry & Machine Co.	Hamilton, Ohio
Johnstone Foundries, Inc.	Grove City, Pennsylvania
Kanawha Manufacturing Co.	Charleston, West Virginia
Koehring Co.	Milwaukee, Wisconsin
Lincoln Foundry Corp.	Los Angeles, California
E. Long Ltd.	Orillia, Ontario
Otis Elevator Co., Ltd.	Hamilton, Ontario
The Henry Perkins Co.	Bridgewater, Massachusetts
Pohlman Foundry Co., Inc.	Buffalo, New York
The Prescott Co.	Menominee, Michigan
Rosedale Foundry & Machine Co.	Pittsburgh, Pennsylvania
Ross-Meehan Foundries	Chattanooga, Tennessee
Shenango-Penn Mold Co.	Dover, Ohio
Sonith Industries, Inc.	Indianapolis, Ind.
Standard Foundry Co.	Worcester, Massachusetts
The Stearns-Roger Manufacturing Co.	Denver, Colorado
Traylor Engineering & Mfg. Co.	Allentown, Pennsylvania
Valley Iron Works, Inc.	St. Paul, Minnesota
Vulcan Foundry Co.	Oakland, California
Warren Foundry & Pipe Corporation	Phillipsburg, New Jersey

"This advertisement sponsored by foundries listed above."

MEEHANITE® PERSHING SQUARE BUILDING • NEW ROCHELLE, N. Y.



"Service when you want it!"

...that's only one of the things we mean by Service Plus!

● Once in a while, a customer finds himself short of an essential piece of steel or equipment. That means delay, perhaps layoffs, if the item is not delivered immediately. And that is when *Service Plus* gets a severe test.

We're glad we have passed these important tests. Some customers have commented: "I like your prompt service." "You have fast and competent service." We hope our customers never find reason to change these opinions.

Service Plus means more than speed. It also means we have in stock a wide range of steels in a variety of shapes and sizes, and we are ready to give courteous, efficient attention to your particular steel supply problem.

BARS · PLATES · FLOOR PLATE · STRUCTURALS · SHEETS · STRIP
REINFORCING BARS · STAINLESS · ALLOY STEELS · ALUMINUM
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WHEN YOU DEAL WITH US, YOU GET Service Plus!

UNITED STATES STEEL SUPPLY COMPANY

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UNITED STATES STEEL

New Materials and Equipment

claimed to have fast wetting, rapid penetrating, and free rinsing properties that insure wetting of deep recesses and loosening the bond between basic metals and soils.

The cleaner is said to be nontoxic and practically odorless, and it will not attack any metal or alloy. S.E.C. can be used as manufactured at room temperature to 140 F or in the form of an emulsion at 1:1 or 1:2 parts water. As a spray, it can be used in the form of an emulsion up to 1:20 parts water.

Electrolytic Cleaner

An electrolytic cleaner developed especially for the job shop plater has been announced by *Detrex Corp.*, Box 501, Detroit 32. It is suitable for use on steel, brass, nickel and die castings.

Called Detrex 53, the cleaner is claimed to have high current capacity, to be free from objectionable foaming and odor, and to be free-rinsing. Completely soluble in hot water at high concentrations, it contains no soaps or resinates. Detrex 53 is also said to be suitable for spray washing, especially on ferrous parts.

Metal Cleaner

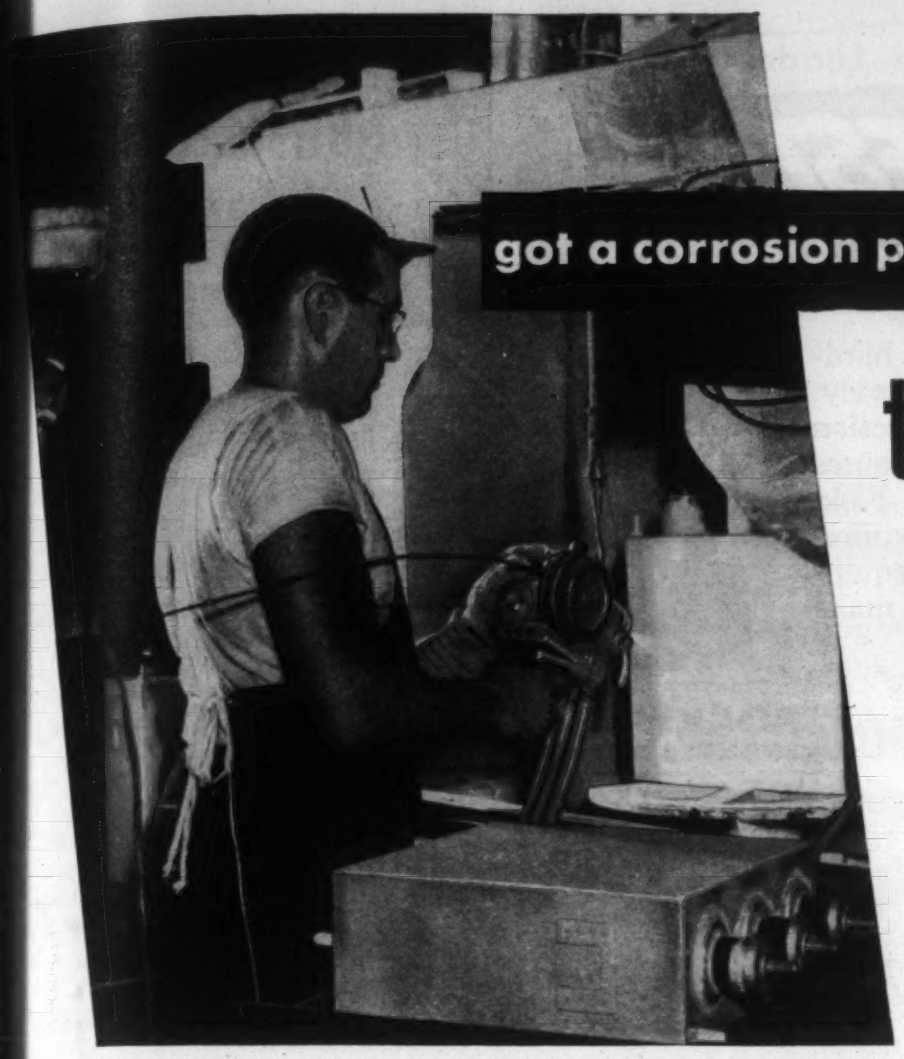
A cleaner developed for pre-cleaning and post-cleaning of welded and silver brazed joints is now available from *Sully Engineering, Ltd.*, 11673 San Vicente Blvd., Los Angeles 49, Calif. Known as Formula 73, it can be used as a flux and is being used for preparation of sweat fittings on copper and brass tubing.

Formula 73 is said to clean copper, brass, steel, iron and stainless steel with a detergent action. It removes fluxes, heat scale and rust, and is claimed to be nonflammable and nontoxic.

Electroplating Rectifier

An oil-immersed selenium rectifier for electroplating, particularly barrel plating, has been announced by the *Lighting & Rectifier Div.* of *General Electric Co.*, Schenectady 5, N. Y.

In order to withstand the corrosive atmosphere of the plating room, the rectifier



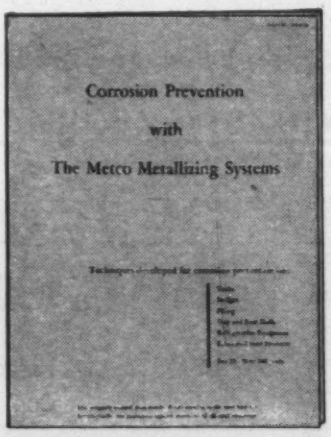
got a corrosion problem with *your* product?

take a tip from Westinghouse!

For many years Westinghouse Research worked on ways of increasing the corrosion resistance of their outdoor type power capacitors. Prior to 1944, the best they had been able to devise was a triple coat of paint —zinc chromate and alkyd resin. Then they tried metallizing the cases with pure zinc, followed by a coat of lacquer to enhance appearance and assist radiation.

No Field Trouble Since—Unlike the paint, the .010″ zinc coating won't chip, and even if scratched, still provides perfect electro-chemical protection against corrosion. Result: not a single instance of field trouble with these capacitor cases since 1944. Experience was so good that in 1947 Westinghouse started zinc metallizing of their indoor type capacitors also. And here's the *extra* pay-off—the zinc spray and lacquer finish costs no more than the baked paint finish previously used.

Engineered and Tested Specs Available—For the past 19 years METCO* has carried on continuous testing of pure metallized zinc and aluminum coatings in corrosion prevention. We now have available the results of this experience in the form of 18 basic engineering specifications, called the METCO SYSTEMS, covering the protection of structures and equipment under a wide range of corrosion conditions. They cover actual immersion in salt or fresh water of various pH factors; exposure to water ballast, condensate and acid solutions; salt, humid, rural and industrial atmospheres ranging from light to heavy. They also include for the first time, provisions for appearance requirements with specific organic coatings, available in a range of colors, all of which have been thoroughly tested for compatability with the metallized zinc or aluminum.



EE BULLETIN—Bulletin 93 describes the basic METCO YSTEMS; tells of typical applications. With it you n choose the SYSTEM fitting your particular corroon problem and then obtain the SYSTEM specificaons covering it. Write today—no obligation, of urse.

R. J. McWaters
Metallizing Engineering Co., Inc.
38-23 30th Street, Long Island City 1, N. Y.

Please send me Bulletin 93. No obligation, of course.

NAME_____

COMPANY_____

ADDRESS_____

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In Great Britain: METALLIZING EQUIPMENT COMPANY, LTD. Chobham near Woking, England

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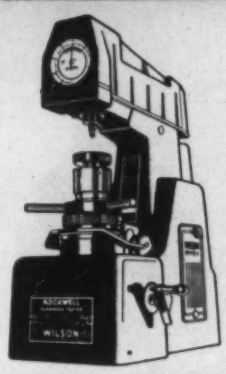
There is only one measure of value in hardness testing equipment: Dependable Accuracy.

WILSON's 27 years of research, production and standardizing of such equipment assures quality approaching perfection. Wilson Field Service Engineers (1) study users' requirements, (2) recommend most suitable equipment, (3) supervise installation and (4) make sure of *continued* faithful service.

Choose WILSON equipment to suit your needs, with pre-assurance of its dependable accuracy.

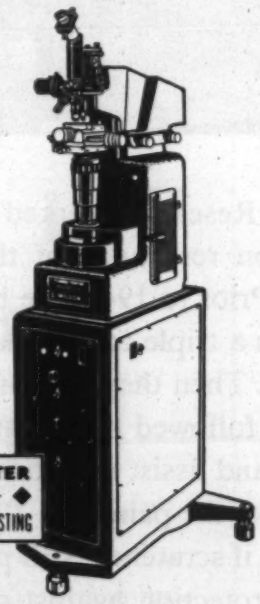


"ROCKWELL" HARDNESS TESTER
Made Only by Wilson

"ROCKWELL" HARDNESS TESTER—developed and made only by Wilson. For laboratory, toolroom or production line testing. Vertical capacities from 3¼" to 16" Motorized models available.

"ROCKWELL" *Superficial* HARDNESS TESTER—especially suited for testing thin material, nitrided or lightly carburized steel and areas too small for regular "ROCKWELL" Hardness Tests. Depth of indentation .005" or less. Satisfactory for general testing where surfaces are smooth and materials homogeneous.

TUKON—for micro-indentation hardness testing with either Knoop or 136° Diamond Pyramid Indenter. Made in 3 models to cover the full range of Micro and Macro Hardness testing with loads from 1 to 50,000 grams.



ACCESSORIES. "*BRALE*" is the only diamond indenter made to Wilson's precision standards. • *TEST BLOCKS*—enable you to keep your instrument "Laboratory" accurate. • *EQUITRON*—fixture provides means for accurately positioning test samples. • *ADAPTER*—permits testing inner cylindrical surfaces with unimpaired accuracy. • *WORK SUPPORTS*—facilitate testing of variously shaped rod stock, tubing or irregular shapes.

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ACCO

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"ROCKWELL" Hardness Tester ☐
"ROCKWELL" Superficial Hardness Tester ☐ TUKON ☐ Accessories ☐

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New Materials and Equipment

utilizes hermetically-sealed selenium stock The unit is available in two models: 6/ v., 1500/750 amp., 230/460 v./a.c., cycles, 3 phase; and 9/18 v., 1500/7 amp., 230/460 v./a.c., 60 cycles, 3 phase.

Acid-Type Cleaning Process

A recent development of *Turco Produc Inc.*, 6135 So. Central Ave., Los Angeles is the Turco 1620 Process, which simplifi acid spray or immersion washing and su face conditioning of ferrous and nonferro metals prior to painting. It is claimed th any existing spray washing set-up of thr or more stages ordinarily can be used wit out modification of established equipme or production lines.

Employing Turco 1620, a new acid-ty cleaner, the process performs three oper tions simultaneously: (1) removes soil an dirt without use of additives, often elimin ing pre-cleaning; (2) provides a firm pai bond; and (3) inhibits rusting, usual eliminating the final chromic acid rinse.

Welding & Joining

Hard-Facing Alloy

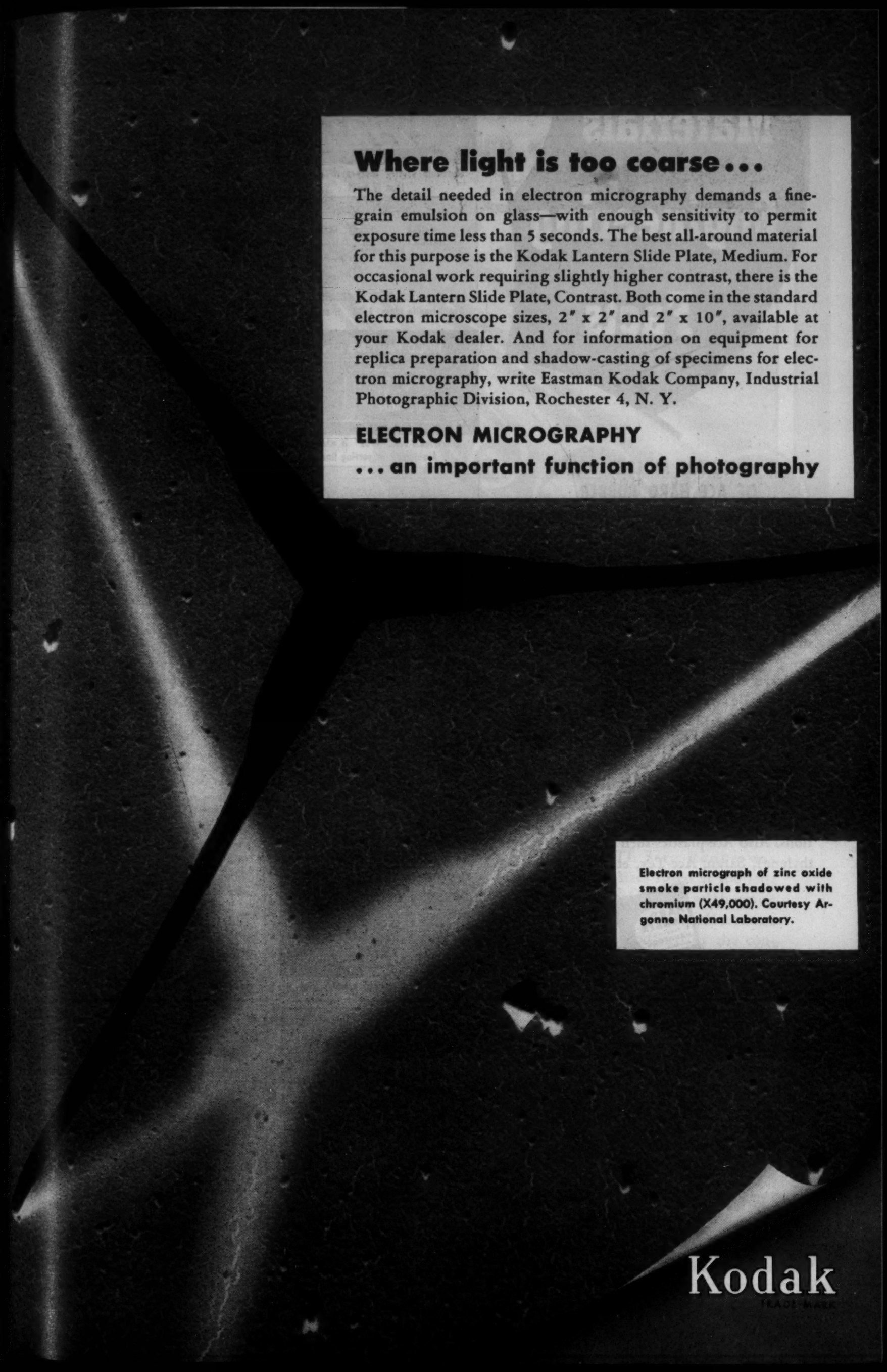
A new hard-facing alloy designed pr marily for applications involving hig stress abrasion with medium impact h been announced by *Air Reduction Sal Co.*, 60 E. 42 St., New York 17.

The Aircolite 59 rod is composed main of chromium, molybdenum, carbon an iron. It has a low coefficient of friction an therefore, acquires a high polish in servic The deposit maintains its high hardne at temperatures up to 800 F.

The new rod is available bare for oxya tylene application or coated for electr application.

Silver Joining Alloy

A silver joining alloy with a remelt tem perature of 1850 F, plus electrical conduc tivity said to be equal to twice that o conventional silver solders, has been an



Where light is too coarse...

The detail needed in electron micrography demands a fine-grain emulsion on glass—with enough sensitivity to permit exposure time less than 5 seconds. The best all-around material for this purpose is the Kodak Lantern Slide Plate, Medium. For occasional work requiring slightly higher contrast, there is the Kodak Lantern Slide Plate, Contrast. Both come in the standard electron microscope sizes, 2″ x 2″ and 2″ x 10″, available at your Kodak dealer. And for information on equipment for replica preparation and shadow-casting of specimens for electron micrography, write Eastman Kodak Company, Industrial Photographic Division, Rochester 4, N. Y.

ELECTRON MICROGRAPHY

... an important function of photography

Electron micrograph of zinc oxide smoke particle shadowed with chromium (X49,000). Courtesy Argonne National Laboratory.

Kodak

TRADE MARK

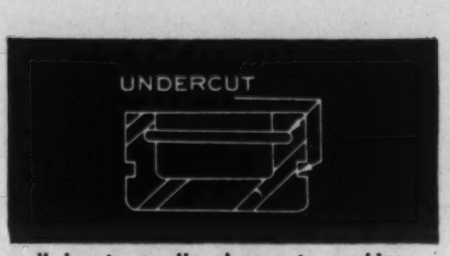
Materials Engineering Facts

HINTS FOR MOLDED PARTS OF ACE HARD RUBBER

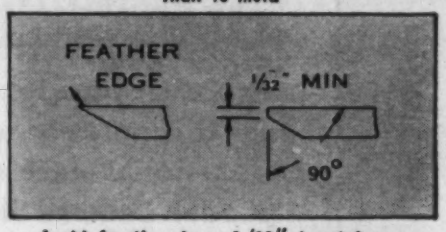
Ace Hard Rubber is a widely used thermo-setting plastic, combining outstanding chemical, physical and electrical characteristics—including high tensile strength, low moisture absorption, high dielectric strength and good machining qualities.

You can choose from Ace compounds which offer tensile strength up to 9700 psi, dielectric strength to 613 v/mil, heat resistance to 300° F. water absorption as low as 0.04—with complete (among world's largest) Ace facilities for design, molding, extruding, machining, finishing, etc.—for parts made the most economical way to your exact specifications. Also Ace plastics such as Parian (polyethylene), Saran, Ace-Tex, etc.

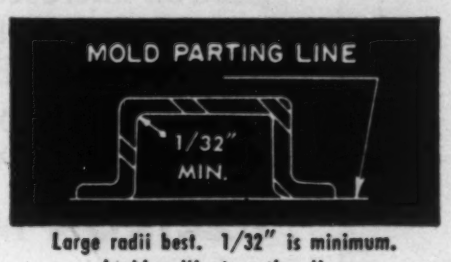
Always check your Ace Hard Rubber and Plastics Handbook when selecting materials. If you haven't a copy of this valuable 60-pg. manual, *write today —it's free.*



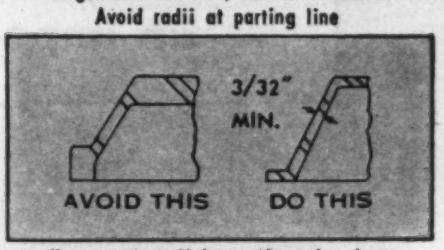
Undercuts usually cheaper to machine than to mold



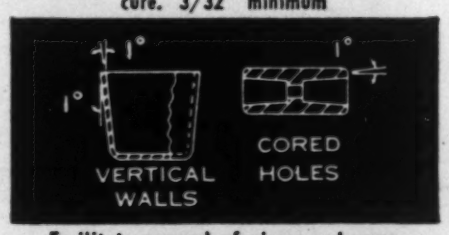
Avoid fragile edges, 1/32" is minimum



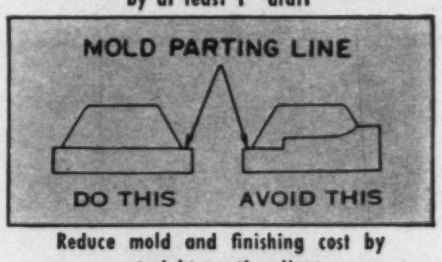
Large radii best. 1/32" is minimum. Avoid radii at parting line



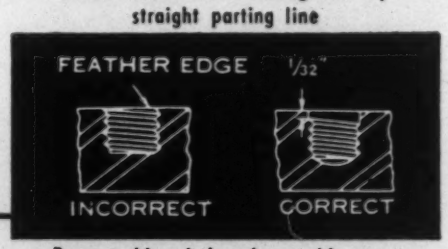
Keep sections light, uniform for short cure. 3/32" minimum



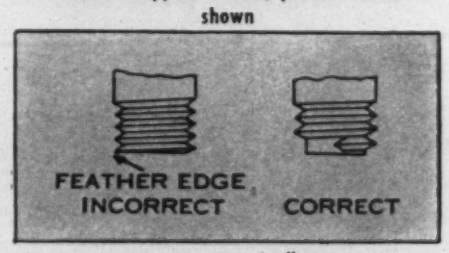
Facilitate removal of pieces and cores by at least 1° draft



Reduce mold and finishing cost by straight parting line



Prevent chipped threads; provide recess shown



Start male threads 1/32" from end

ACE AMERICAN HARD RUBBER COMPANY
Since 1851
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New Materials and Equipment

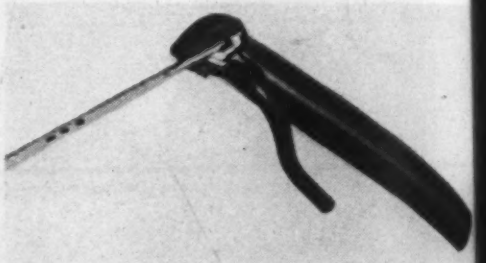
nounced by *Eutectic Welding Alloys Cor* 40 Worth St., New York 13. Thus, Eute Rod 1807 withstands normalizing and he treating temperatures, and requires on half the normal overlap on copper bu joints to accommodate full current.

The alloy has hardness of 64 to 7 Brinell, tensile strength of 30,000 32,000 psi., and good corrosion resistanc Sizes available are 1/64-, 1/32-, 1/16- an 1/32-in. coils.

Electrode Holder

A new insulated electrode holder, calle Lincoln LJ-1, has been introduced b *Lincoln Electric Co.,* 13010 Coit Rd., Cleve land 1, Ohio.

Of unusually small size, it is said t combine the advantages of both tong an hole type holders in providing a stron electrode grip, yet easy thumb pressur



Small size of this Lincoln electrode holde makes it easy to use.

electrode release. The holder's small size makes it suitable for operation with heav gloves and in corners and other confine areas.

The holder, designed for both strength and insulating qualities, is available in the 250-amp. size for 1/16- to 3/16-in. elec trodes.

Hard-Facing Alloy Rods

Stoody Co., 11934 E. Slauson Ave., Whit tier, Calif., has recently announced new a.c.-d.c. coatings for several hard-facing electrodes formerly limited to d.c. applica tion only. These electrodes include Stoo dite, Tube Borium and Borod.

With this development, all Stoody alloys are now available for a.c. and d.c. applica tion, with the exception of Tube Stoodite, which is strictly an oxyacetylene rod. The a.c.-d.c. coated rods do not replace the older d.c. types but are additions to the regular line.

STAINLESS STEEL MECHANICAL AND PRESSURE TUBING

These are common sizes. Intermediate sizes, larger or smaller diameters, heavier or lighter walls, or geometric shapes other than round also are available.

OUTSIDE DIAMETER	GAUGE RANGE	OUTSIDE DIAMETER	GAUGE RANGE
3/8"	16-25	1-11/16"	10-20
7/16"	16-25	1-3/4"	10-20
1/2"	14-25	1-7/8"	10-20
9/16"	14-25	2"	9-20
5/8"	14-24	2-1/8"	9-20
11/16"	14-24	2-1/4"	9-20
3/4"	13-24	2-3/8"	8-20
13/16"	13-24	2-1/2"	8-20
7/8"	12-23	2-5/8"	8-20
15/16"	12-23	2-3/4"	8-20
1"	11-23	2-7/8"	8-20
1-1/16"	11-22	3"	8-20
1-1/8"	11-22	3-1/4"	8-16
1-3/16"	11-22	3-1/2"	8-16
1-1/4"	11-22	3-3/4"	8-16
1-5/16"	11-20	4"	8-16
1-3/8"	11-20	4-1/4"	8-16
1-7/16"	11-20	4-1/2"	8-16
1-1/2"	10-20	4-3/4"	8-16
1-9/16"	10-20	5"	8-16
1-5/8"	10-20		

The above sizes are available in types 304, 309S, 310, 316, 317, 321, 347 and 430. Type 302 is available in a limited range of sizes for ornamental use.

STAINLESS STEEL PIPE

NOMINAL PIPE SIZE	OUTSIDE DIAMETER	SCHEDULE 40S STANDARD PIPE WALL THICKNESS	SCHEDULE 10S LIGHT WALL PIPE WALL THICKNESS
1/8"	.405	.068	.049
1/4"	.540	.088	.065
3/8"	.675	.091	.065
1/2"	.840	.109	.083
3/4"	1.050	.113	.083
1"	1.315	.133	.109
1-1/4"	1.660	.140	.109
1-1/2"	1.900	.145	.109
2"	2.375	.154	.109
2-1/2"	2.875	—	.120
3"	3.500	—	.120
3-1/2"	4.000	—	.120
4"	4.500	—	.120

The above Pipe Sizes are available in the Chrome-Nickel analyses of Republic ENDURO Stainless Steel.

ELECTRUNITE

Stainless Steel Tubing and Pipe

● NOW . . . up to and including 5" O.D. . . . ELECTRUNITE Tubing made of time-tested Republic ENDURO* Stainless Steel.

In 1947, the ELECTRUNITE Size Range was expanded to include the pipe sizes listed at the left. Today, Steel and Tubes keeps pace with your expanded requirements by offering a complete range of stainless steel tubing sizes produced by the continuous welding method.

Republic—world's largest producer of stainless and alloy steels—offers you prompt metallurgical assistance with any problem involving the use of stainless steel tubing or pipe. Write, wire or phone *today* for further information.

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STEEL AND TUBES DIVISION • CLEVELAND 8, OHIO
Export Dept.: Chrysler Bldg., New York 17, N. Y.

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Insist on Prest-O-Lite
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Cups
Receivers
Pressure Vessels
Containers
Other Formed Parts

Made to Your Exact Specifications

- In conventional or unusual contours
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Higher Quality—Longer Life

- Extreme uniformity of size, weight, strength, capacity and wall thickness
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LINDE engineers will gladly help you with your designs, specifications and production problems involving cold-drawn shells and shapes or formed metal parts. Just mail the coupon for full information.

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Send literature and full information about deep-drawn shapes and shells.

NAME_____

COMPANY_____

ADDRESS_____

New Materials and Equipment

Welders

A complete new line of transformer-type a.c. arc welders which have no moving parts has been announced by *Hobart Bros. Co.*, Troy, Ohio.

An electrically adjustable reactor makes available about 500 different welding current settings without the necessity for

The new line of Hobart welders has no moving parts.

cranking or changing electrode or ground cable connections. The machine also provides a higher than normal current at the arc for a fraction of a second, thus giving the operator an instantaneous striking arc.

Two models are available. Model TSP-205-C with power factor correction is rated 200 amp. at 30 v. It is designed to operate on single-phase 60 cycles and either 220/440 dual voltage or 550 v. It can also be supplied for 50 cycles.

Model TSP-182-C with power factor correction and limited input for operation on REA lines is rated 180 amp. at 25 v. It is designed to operate on single-phase 60 cycles and 230 v., to comply with REA specifications for welders used on their 3KVA transformers.

Argon Metal Arc Welding

A new machine for automatic welding of aluminum by the argon shielded metal arc welding process has been announced by *The Linde Air Products Co.*, 30 E. 42 St., New York 17.

This welding machine uses an arc main-

AEROTURN Dust Collector, Series 18, with part of housing removed to show felt filters and automatic cleaning device.

THIS Aeroturn Dust Collector features the use of tough, flame, acid-and-alkali-proof filter felt made by American. It provides 99.9% efficiency, due to the positive filtration action of the felt, a product of advanced research work and felt manufacturing know-how. The Turner & Haws Engineering Co., Inc., West Roxbury 32, Mass., maker of the Aeroturn, states that: "Basically, the exceptional performance of Aeroturn Collectors is made possible by the high-quality specialized filter felts made by your company." Another Aeroturn feature is uninterrupted operation made possible by the reverse-air-jet filter bag blow ring. Increase of static pressure puts this into operation automatically. This, plus the high filtering rate of the felt, makes an Aeroturn installation smaller and lighter for a given capacity. . . . The success of this dust collector is an example of the results obtainable through close cooperation between a manufacturer and his suppliers. American works closely with Aeroturn, and will gladly collaborate with you on filtration or any other application for felt. Write for Data Sheet No. 15, "Felt and Filtration," complete with technical information and illustrative samples.

American Felt Company

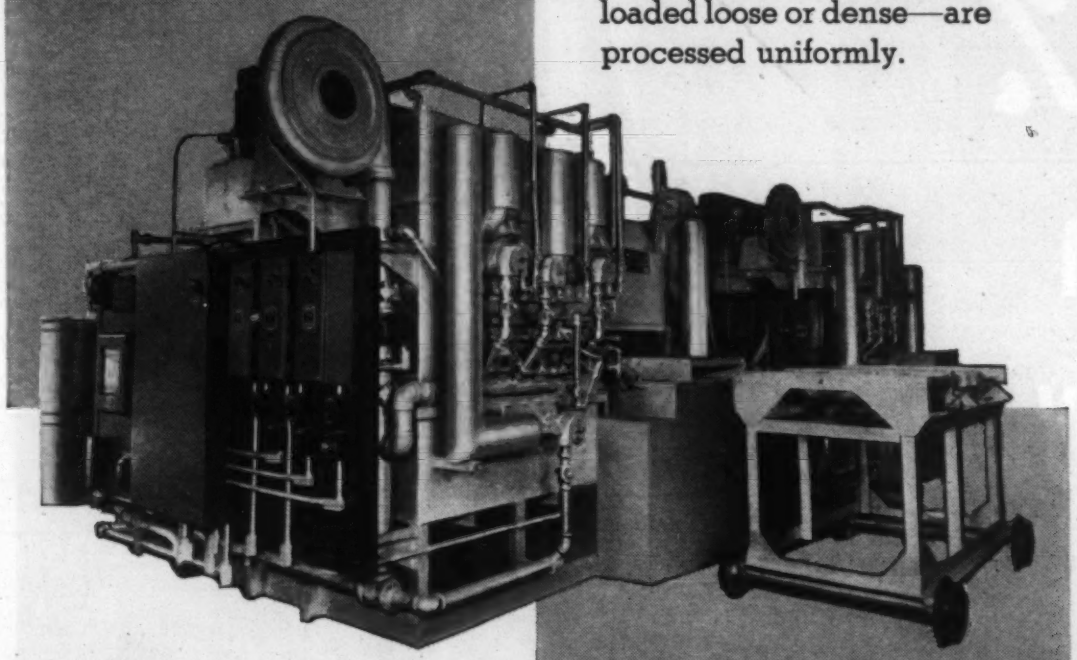
TRADE MARK

GENERAL OFFICES: 00 GLENVILLE RD., GLENVILLE, CONN.— ENGINEERING AND RESEARCH LABORATORIES: GLENVILLE, CONN. — PLANTS: Glenville, Conn.; Franklin, Mass.; Newburgh, N. Y.; Detroit, Mich.; Westerly, R. I. — SALES OFFICES: New York, Boston, Chicago, Detroit, Cleveland, Rochester, Philadelphia, St. Louis, Atlanta, Dallas, San Francisco, Los Angeles, Portland, Seattle, Montreal.

...BLAZING THE HEAT-TREAT TRAIL...

New Production-line *Holcroft* batch-type furnace

This compact heat-treat furnace has a vestibule, heating chamber, quenching tank—*all above floor level and in one unit.*



does more jobs...

You'll be able to handle a wide variety of jobs at temperatures ranging from 400° to 1700° F., and get clean, scale-free work. All contamination is removed by a high flow of generator gas in the vestibule. The furnace fan circulates atmosphere so that parts—loaded loose or dense—are processed uniformly.

...faster...

The furnace can be operated automatically, or manually, by push-button controls. To save time, the temperature is built up between cycles to a point higher than necessary; then the normal operating temperature control is resumed after the cool parts enter the furnace. The quench tank handles the full load in one operation.

at a lower cost!

The furnace requires minimum floor space, no pit for the quenching tank. It can be moved easily—as a unit—to any part of the production line. Trays last longer because they are carried—*not* pushed or pulled while hot.

Want more information? Write us today!

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BUILT BY HOLCROFT & COMPANY DETROIT-MICH.

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4209 South Western Blvd.	6516 Detroit St.	5724 Navigation Blvd.	Windsor, Ontario	Paris 8, France

New Materials and Equipment

tained in a shield of argon gas between the consumable filler-metal electrode and

Linde's FSM-1 machine is being used here to weld aluminum car tanks of plate 1⅛-in. thick.

the workpiece. The electrode, supplied as a coil of wire, is deposited across the arc into the weld as filler metal.

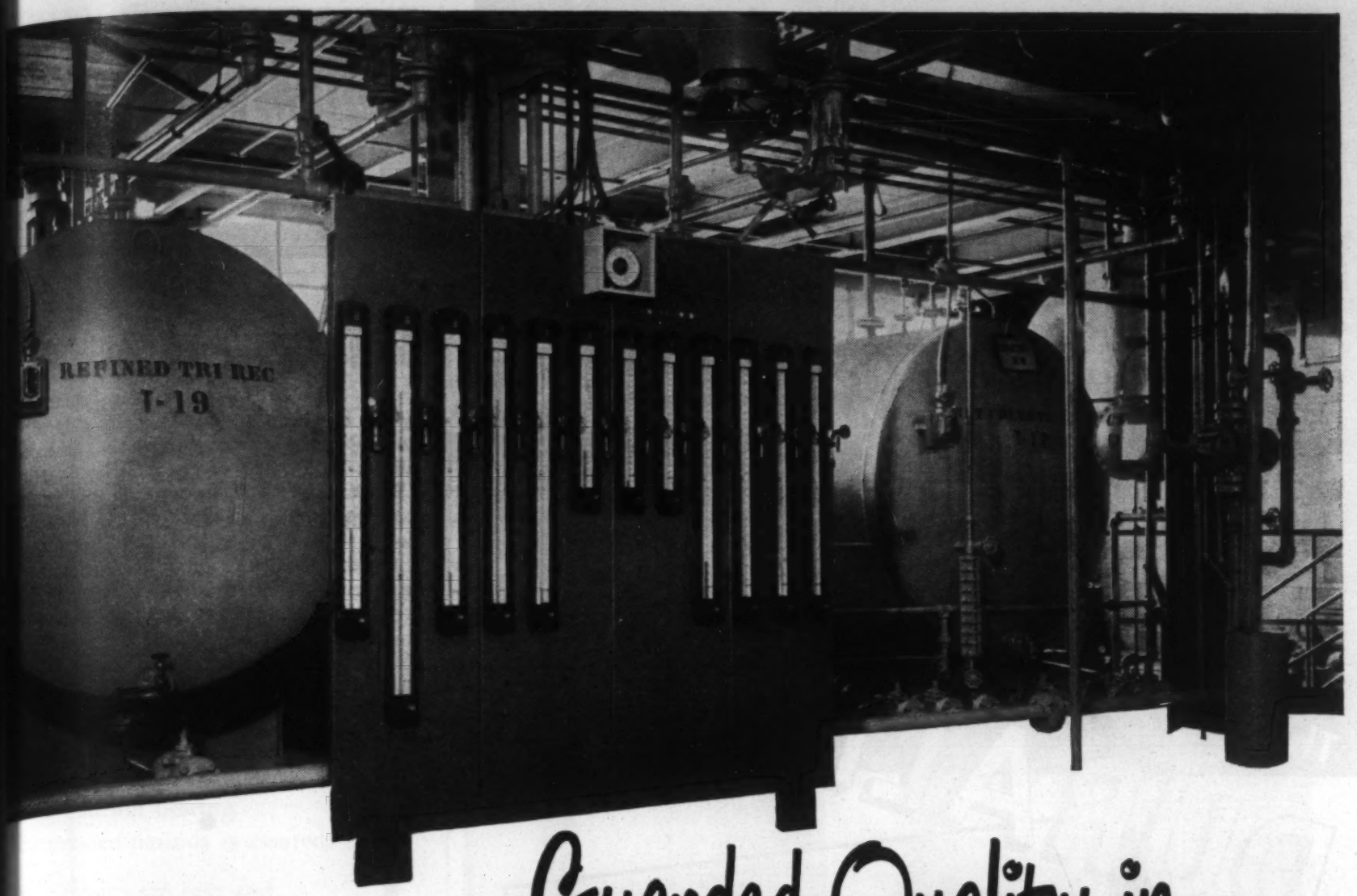
The process is applicable to either machine or hand welding; the equipment for mechanized welding is known as the Linde FSM-1 machine. It can be used for all the metals which are readily joined by Heliarc welding, but initial effort is being concentrated on the welding of aluminum plate.

Smooth, clean welds are claimed and no flux is used. As a result, cost of cleaning and finishing the welds is reduced and the possibility of flux corrosion or entrapment is eliminated. Almost any thickness can be welded by a suitable number of passes. With the FSM-1 machine, butt-welding is performed in the flat position, and fillet and lap welding in the flat and horizontal positions.

Vinyl Sheeting Adhesive

An adhesive to glue vinyl sheeting to porous surfaces has been developed by *Thomas W. Dunn Co.*, Pearl and Dover Sts., New York 7.

Known as Vinyl-hesive, the adhesive is a water-thinable emulsion type compound that can be applied with conventional equipment or by brushing. Chief advantages claimed for the adhesive are: (1) non-staining properties which allow vinyls to be laminated to various surfaces with a minimum of discoloration; (2) ability to bond all flexible formulations of vinyls to paper, pressboard, cardboard, masonites, felt, and other porous surfaces; (3) resistance to aliphatic hydrocarbons, oils, greases, water, and deterioration by bacteria and fungi; and (4) relatively non-toxic properties, making it applicable in food packaging industries.



Guarded Quality in
NIALK TRICHLORethylene

The most modern facilities in the industry are behind the production of NIALK* TRICHLORethylene.

So . . . for a metal-cleaning and degreasing agent of highest quality and stability, order from Niagara.

A PAMPHLET containing information on properties of NIALK TRICHLORethylene is available on request. Just send in coupon below.

*Trade-Mark

NIAGARA ALKALI COMPANY

60 East 42nd Street, New York 17, New York

EBC Liquid Chlorine*
NIALK Caustic Potash
NIALK Carbonate of Potash
NIALK Paradichlorobenzene
NIALK Caustic Soda
NIAGATHAL (Tetrachloro Phthalic Anhydride)*
NIALK TRICHLORethylene

Niagara Alkali Company, Dept. F
60 East 42nd Street, New York 17, N. Y.

Gentlemen: Please send me a copy of your pamphlet on NIALK TRICHLORethylene.

Name_____

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Firm_____

Street_____

City_____ State_____

The Furnace Roller is

DURALIZED!

And what is "Duralizing"?

It's a surface treatment given to the casting

1 . . . to make it more resistant to abrasion
2 . . . to make it more resistant to molten metal
3 . . . to minimize "pick up"

This is a treatment we developed in our own laboratory and foundry to meet special conditions for certain furnace operations. Normal high alloy castings would withstand the heat all right but abrasion, erosion and pick up were something else again. The "Duralized" Rolls solved the problem.

While you may not need a high alloy casting calling for the Duralizing treatment, you may have a high alloy casting problem. We'll be glad to study it with you and recommend the alloy and type of casting best for your requirements.

THE DURALOY COMPANY

Office and Plant: Scottdale, Pa. • *Eastern Office:* 12 East 41st Street, New York 17, N. Y.

F. O. NELSON, 1743 McCormick Building, Chicago, Illinois
F. B. CORNELL & ASSOCIATES, Detroit
METAL GOODS CORP. St. Louis • Houston • Dallas • Tulsa • New Orleans • Kansas City

New Materials and Equipment

Arc Welding Electrode

An improved arc welding electrode, W-52, has been announced by the *Apparatus Dept.* of *General Electric Co.*, Schenectady 5, N. Y. The reverse polarity d.c. rod, AWS Class E7010, is designed specifically for welding of low-alloy high-strength steels, such as pipe lines, in all positions.

Good bonding action at the fusion zone on horizontal fillets and less tendency to produce pin holes on vertical downwelds are claimed for the new electrode. Its stable arc with low spatter smooths operation and eliminates tendencies to short out in confined joint preparations.

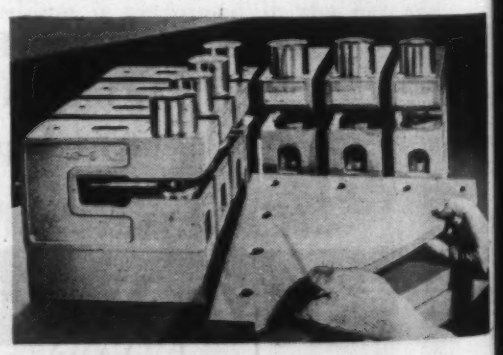
•

Forming & Machining

Hole Punching Units

Development of new Wales Type "G" hole punching units has been announced by the *Wales-Strippit Corp.*, North Tonawanda, N. Y.

These extra heavy-duty units are equipped with "Split Punches," which eliminate the



This stamping press set-up of Wales Type "G" Hole Punching Units punches holes through a ½-in. thick gusset.

tremendous stripping pressures and oversize stripping springs always encountered in stripping punches out of punched holes. The three-piece "Split Punch" collapses sufficiently to free itself from the wall after punching the hole. For this reason, only a series of small lifter springs are required to raise the punch assembly to the "up" position.

After a simple, quick assembly operation, the units are ready to begin punching without adjustment of units, punches or dies.

Why HEVI DUTY selected GLOBAR Heating Elements for new furnace design

Among the many reasons why GLOBAR silicon carbide heating elements are best suited for this new design in laboratory furnaces—dependable high temperature performance stands out. Continuous operation in the 2000°F to 2600°F range places no severe demands on element life. Response to thermal control requirements is fast and accurate. Clean, silent, uniform heating for extended periods is assured.

The elements are easy and convenient to service. All terminal connections are external. Replacements can be made in minutes... while the furnace is at temperature. Working conditions are cleaner and safer too. There is no explosion or fire hazard.

GLOBAR heating elements are being used to advantage in an increasing number of industrial heating applications. They may provide the answer to your heating problems. Complete details are available through Department W-80, The Carborundum Company, GLOBAR Division, Niagara Falls, New York.

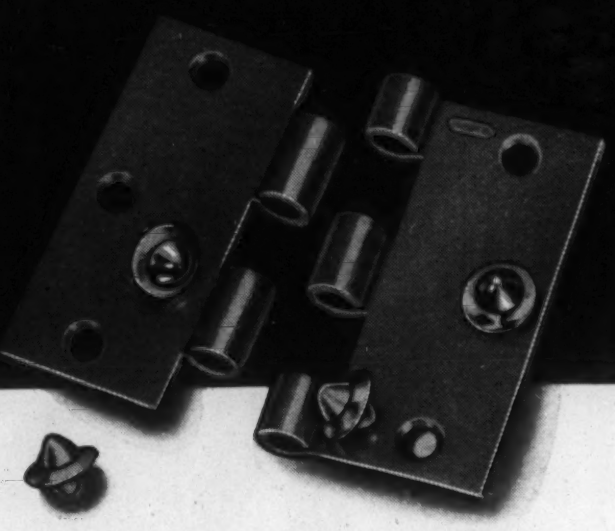
This new HEVI DUTY ELECTRIC CO. furnace features an improved insulation design with minimum of radiation loss...incorporates the most recent developments introduced by HEVI DUTY engineers.

GLOBAR Heating Elements BY CARBORUNDUM

TRADE MARK

"Carborundum" and "Globar" are registered trademarks which indicate manufacture by The Carborundum Company

in BURNISHING MATERIALS



it's the SHAPE that counts!

For better burnishing of flat surfaces joined to curved or cylindrical sections . . . use Abbott Burnishing Cones. They're shaped to do the job right!

Abbott Burnishing Materials, available in five shapes — Ball, Overball, Diagonal, Cone, Pin — are scientifically designed to make effective contact on metal stampings or castings of any size and shape. Each piece is a burnishing tool made from Abbott's high quality bearing ball steel. Each is deep hardened and polished to a mirrorlike, glass-hard finish. For consistently better burnishing results . . . use Abbott!

Some parts require a special mixture of Abbott Burnishing Materials. Send for catalog showing sizes, shapes, uses. No obligation.

THE ABBOTT BALL COMPANY

1074 New Britain Ave., Hartford 10, Conn.

ABBOTT

the all round ball

New Materials and Equipment

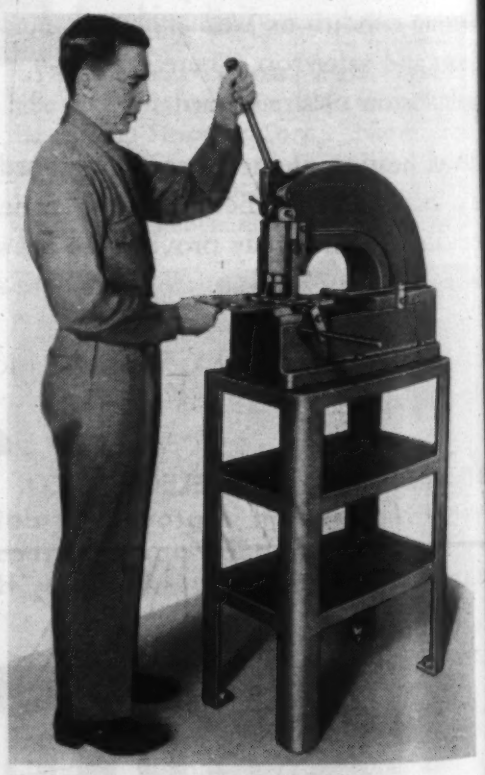
Hard-Metal Drill

A new drill designed especially for metals up to 66 Rockwell C hardness has been developed by *Firth Sterling Steel & Carbide Corp.*, McKeesport, Pa. The new drill will penetrate materials having hardness equal to that of high-speed tool bits, hardened steel files or the softer grades of carbides. The Firthite drills are stocked in sizes ⅛, 3/16, ¼, 5/16, ⅜ and ½ in., and packaged in complete sets of six in pocket-size kits.

The drills are ground from solid sintered carbide cylinders. It has been found that costs are lowered by using solid carbide construction rather than brazing carbide tips to carbon steel shanks.

Punch

A punch with a 12-in. throat which allows working to the center of a 24-in. wide sheet is being made by *O'Neil-Irwin Manufacturing Co.*, Lake City, Minn. Known



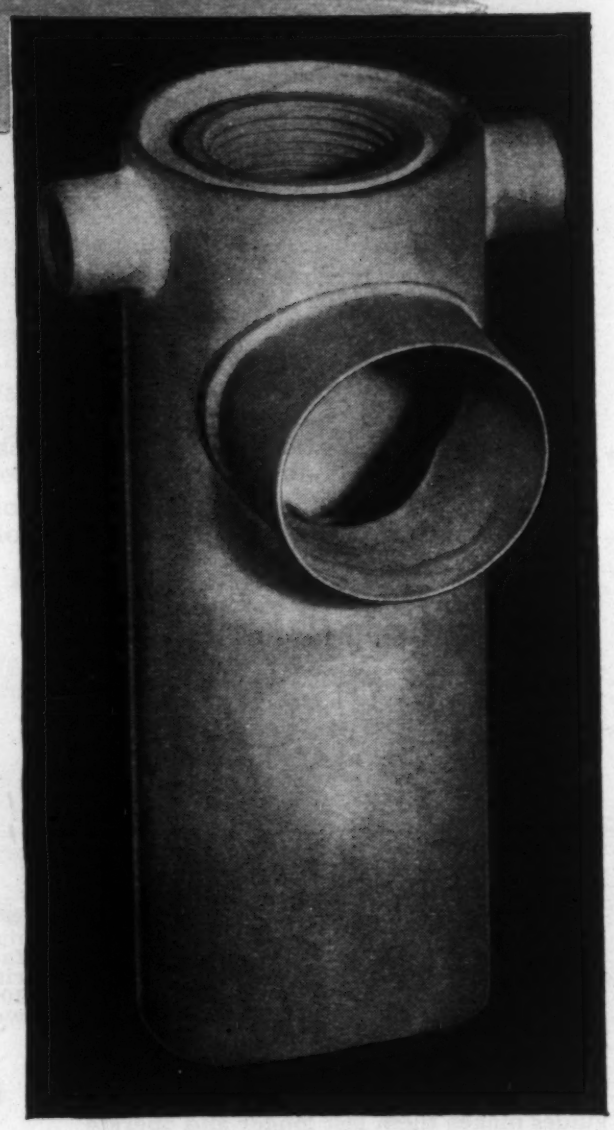
Greater throat depth is available in Di-Acro Punch No. 2.

as Di-Acro Punch No. 2, it has been designed to provide greater throat depth than has been heretofore available in the Di-Acro punch line.

In addition to its ability to perforate holes of various shapes and sizes as large as 4-in. dia., it can also be used as a pre-

HOW TO TAME STAINLESS STEELS

The various types of stainless steel can be as difficult as lions and tigers when it comes to joining them. But EASY-FLO, the low-temperature silver brazing alloy makes them sit up and purr like kittens. For example, the air tube illustrated is made of four different types of stainless steel. The outer tube is made of type #302. The two small drain bushings are type #303. The inside bracket is type #310. The large bushing inside the flange is type #416. EASY-FLO joins them all without difficulty. It makes a practically indestructible assembly—and does it fast and economically.



. . . . AND THIS ARTICLE GIVES YOU DETAILS

If you work with stainless steels you'll find the data in this article of interest. It tells how to join stainless steels with low-temperature silver brazing alloys and gives the technical findings of our Research Laboratory on the subject. A reprint of the article is yours for the asking Write for it—today.

HANDY & HARMAN

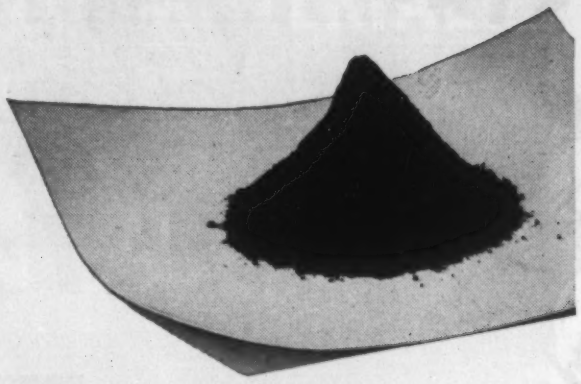
HANDY & HARMAN FOUNDED 1867 QUALITY SERVICE

82 FULTON STREET NEW YORK 7, N. Y.

BRIDGEPORT, CONN. • CHICAGO, ILL. • LOS ANGELES, CAL. • PROVIDENCE, R. I. • TORONTO, CANADA • AGENTS IN PRINCIPAL CITIES

A little heap of powder . . .

THAT DOES A HEAP OF THINGS



Versatile Carboloy Cemented Carbide makes better, longer-lived machine and product parts

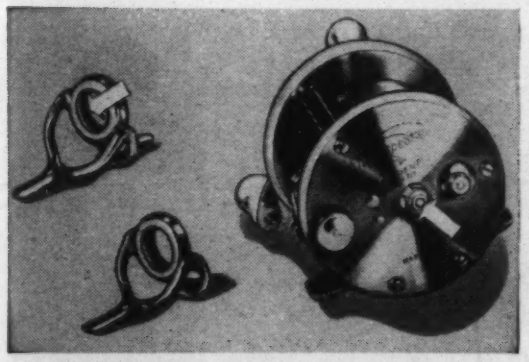
YES, THIS little heap of powder is mighty important, for it is the base of Carboloy Cemented Carbide—the *hardest metal made by man*. And it is no secret that Carboloy is doing a host of valuable jobs!

In fact, the accomplishments of this versatile metal have sometimes bordered on the sensational. Because of Carboloy's exceptional physical characteristics, lives of some machine parts or products have been increased as much as a hundred times!

Countless manufacturers have slashed costs substantially because Carboloy Cemented Carbide has increased their production and improved product quality. Others have found that Carboloy parts in machines made equipment last longer, operate more efficiently.

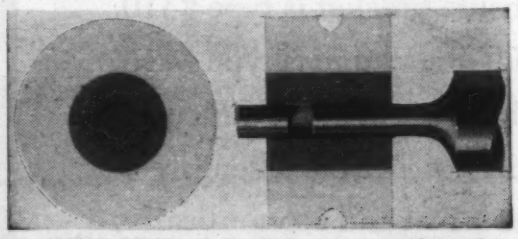
Better look into the possibilities of this versatile metal for your company. Carboloy Cemented Carbide can do a heap of things!

Accomplishments like these are typical!



A LITTLE PIECE of Carboloy used here as a bearing gives fishermen a better, smoother-acting, longer-lived reel. And a little, wear-resistant Carboloy ring in these fish rod guides makes them last longer and operate more smoothly, by combating wear.

A LITTLE PIECE of Carboloy, in modern metal-working machines, steps up production efficiency, reduces downtime. Wear-resistant Carboloy used at wear points on cams, cam followers, pins for knurls, stops, trip fingers and machine ways can increase their lives many times.



A LITTLE PIECE of Carboloy inserted in this mould produced big savings for a manufacturer of highly abrasive ceramic materials. He upped production from 700 to 100,000 pieces, thanks to the extraordinary wear-resistance properties of Carboloy.

PUT CARBOLOY TO WORK FOR YOU

Very likely your company can use Carboloy Cemented Carbide profitably . . . just as thousands of others have. Why not find out now how Carboloy, used in machine or product parts, can help you step up production efficiency, save money and improve the quality of your product. Talk things over with our engineers; they will be glad to advise you without obligation.

CARBOLOY COMPANY, INC.
11161 E. 8 Mile Street, Detroit 32, Michigan

CARBOLOY® HARD METAL
CEMENTED CARBIDE

The Versatile Metal of Industry

New Materials and Equipment

cision punch press for an unlimited variety of blanking, drawing, embossing and forming operations. Its rated material capacity is a 2-in. dia. hole in 16-gage steel plate.

Molding

Injection Molding Machine

What is claimed to be the world's largest injection molding machine for making plastic products has been completed by the *Watson-Stillman Co.* of Roselle, N. J.

It is capable of pressing out, in one operation, thermoplastic products weighing approximately 200 oz. Weighing 115,000 lb., it is operated by a 60-h.p. motor and has a nozzle pressure of 21,000 psi.

There is a 54-in. daylight opening, and the size of the platen is 60 by 40 in., while the overall dimensions are 24 ft.-8 in. long, 5 ft. wide, and 12 ft.-11 in. high. The hopper holds 300 lb. of plastic raw materials, and the clamping capacity is 1000 tons.

Plastic Compression Molding Machine

Announcement of a new fully automatic high-speed plastic molding machine has been made by *Baker Brothers, Inc.*, P. O. Box 101, Station F, Toledo, Ohio.

Main features claimed for the basic 15-ton hydraulic press are (1) the opening and closing speeds, approximately 400 in. per min.; (2) the greatly increased production rates that can be continuously maintained; and (3) the fact that it is a self-contained plastic machine, requiring only electrical connection and a source of 75 to 100 psi. air pressure.

In designing the machine, the new alkyd molding compounds were kept in mind, since their flow characteristics require a very fast closing speed.

A similar machine has also been revealed in a 30-ton size, which has the advantage of increased molding pressure and greater flexibility. In this machine, the last 2 in. of closure can be varied to a speed of from

How COSTS were CUT 40%

IN THE PRODUCTION OF THIS STEEL SCREW

HEAT TREATING...*Eliminated*

HARDNESS TESTING..*Eliminated*

STRAIGHTENING...*Eliminated*

PRODUCTION TIME...*Cut 50%*

...by replacing a .40 Carbon Alloy Steel with STRESSPROOF

This cylinder sleeve puller screw was originally made of .40 carbon alloy steel at a cost of $1.364 per part. By changing to STRESSPROOF furnace-treated bar stock, the manufacturer was able to cut his steel cost, eliminate heat treating, and reduce machining time. As a result, the cost of the finished part dropped to $.818—a net saving of 40%.

STRESSPROOF has made similar savings in hundreds of other cases. Here are four reasons why: 1. STRESSPROOF eliminates heat treating—its *in-the-bar* strength is twice as great as ordinary cold-finished shafting; 2. STRESSPROOF eliminates case hardening—its resistance to wear as machined is sufficient to replace many heat-treated or carburized steels; 3. STRESSPROOF has *in-the-bar* machinability fully 50% better than that of heat-treated alloys of the same hardness; 4. STRESSPROOF is stress-relieved—assuring an absolute minimum of distortion. And yet, this bar costs little more than ordinary cold-finished carbon bars. Available in cold-drawn or Ground and Polished finish.

Stocked by Leading Steel Warehouses

La Salle *

STRESSPROOF

Reg. U.S. Pat. Off.

SEVERELY COLD-WORKED FURNACE-TREATED STEEL BARS

*Mfr. of the Most Complete Line of Cold-Finished and Ground and Polished Bars in America

SEND for FREE

ENGINEERING BULLETIN

"New Economies in the Use of Steel Bars"

LaSalle Steel Co.
1418 150th Street
Hammond, Indiana

Please send me your STRESSPROOF Bulletin.

*Name*_____

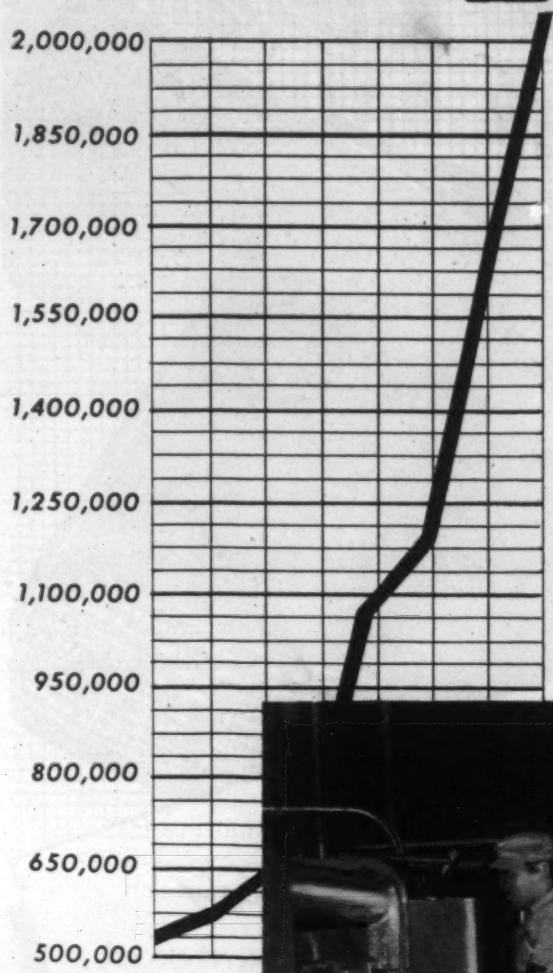
*Title*_____

*Company*_____

*Address*_____

*City*_____ *State*_____

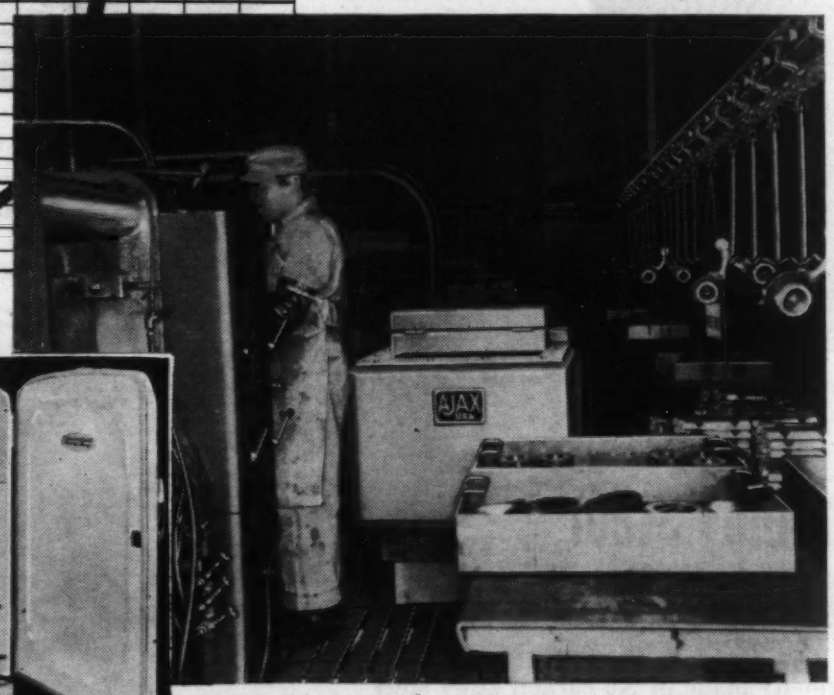
Over 2 Million



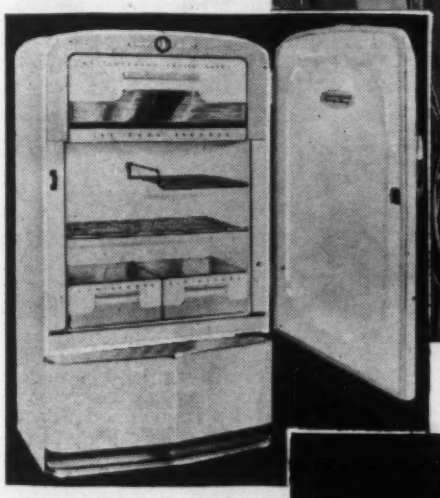
Electric Motors produced monthly in the U.S.A. -- more and more manufacturers are installing

AJAX

ELECTRIC FURNACES to improve production.



Part of the modern die casting plant of the Westinghouse Electric Corporation in Springfield, Massachusetts, where thousands of rotors are cast every day for refrigerator units.



The new Westinghouse Refrigerator Model MF-7.

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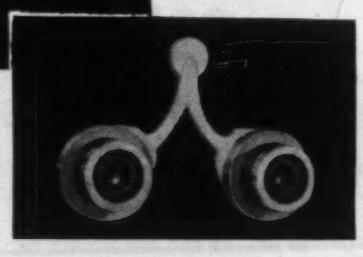


Cast two at a time, these aluminum motor rotors are better because of accurate temperature control and freedom from contamination made possible by Ajax Induction Furnaces.

Included in the millions of motors manufactured nationally, per month, are the hundreds of thousands of fractional horse-power motors that fill the ranks of faithful, alert and silent servants for the American home. Such large output requires ingenious production methods. A great improvement has been achieved by casting the rotors from high purity aluminum. Prominent manufacturers have recognized the advantage of using Ajax-Tama-Wyatt induction furnaces for melting the aluminum prior to casting, because of the accurate temperature control and freedom from contamination with iron or silicon.

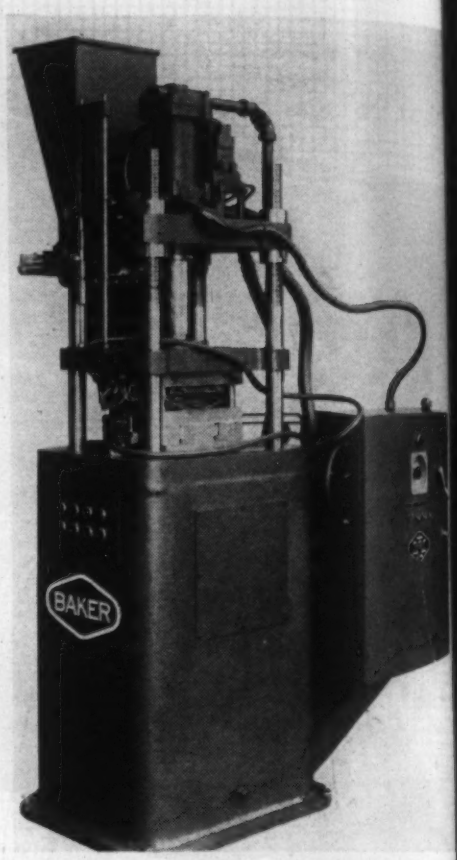
Write today for information about this modern method of increasing precision production.

AJAX ENGINEERING CORPORATION • Trenton 7, New Jersey

AJAX TAMA-WYATT **INDUCTION MELTING FURNACE**

AJAX ELECTRO METALLURGICAL CORP., and Associated Companies
AJAX ELECTROTHERMIC CORP., Ajax-Northrup High Frequency Induction Furnaces
AJAX ELECTRIC CO., INC., The Ajax-Hultgren Electric Salt Bath Furnace
AJAX ELECTRIC FURNACE CORP., Ajax-Wyatt Induction Furnaces for Melting

New Materials and Equipment



This view of the Baker Bros. plastic molding machine indicates its flexibility and the controls that are available for automatic cycling or individual operation of its components.

between 0 and 180 in. per min., as required with phenolic molding compounds. With the 30-ton machine there is also incorporated a bumping or de-gassing cycle.

Both presses require only periodic loading of powder and removal of the finished parts by the operator.

•

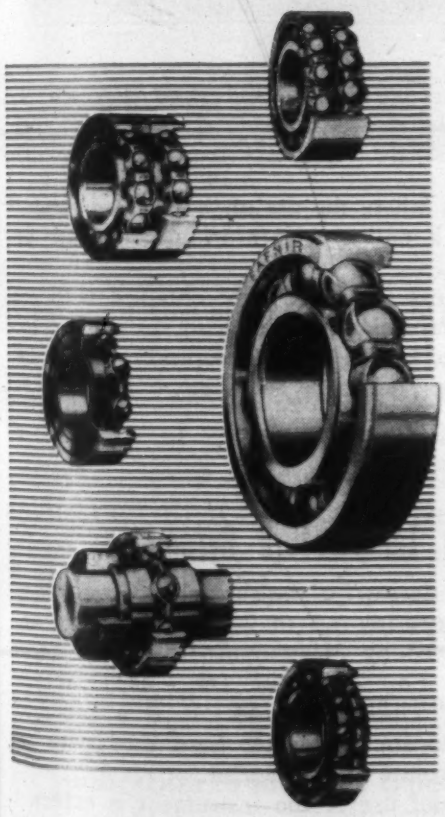
Testing & Control

Electronic Recorder

An electronic recorder featuring a multi-position switch for strain magnification selection has been announced by *Tinius Olsen Testing Machine Co.*, 1054 Easton Rd., Willow Grove, Pa.

The switch selects magnifications of 1000:1, 500:1, 250:1, 100:1, 50:1, 20:1 and 10:1 without gear changes. The unit can be used with either an extensometer or compressometer for recording tension, compression and transverse test data.

HERE'S HOW...



FAFNIR USES 20 LINDBERG CYCLONES

...to draw thousands of types of bearings!

The Fafnir Bearing Company, New Britain, Conn., uses Lindberg Cyclone Furnaces to draw thousands of types and sizes of its line of ball bearings. They say:

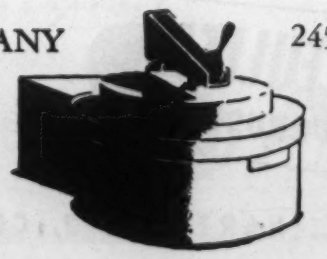
"The metallurgical department of our company entrusts the major part of its drawing operations to Lindberg Cyclone Furnaces because it has found them to be dependable work horses. At the present time there are 20 in use in the Company's three ball bearing plants in New Britain, Conn.

"They have given excellent continuous service for more than 8 years. For long periods they were operated 24 hours a day, seven days a week, (at temperatures ranging from 275 to 1200°F.) without downtime due to furnace failure.

"Because the Fafnir line of ball bearings,comprising thousands of types and sizes, is considered the most complete manufactured in this country, the Lindberg Cyclones draw a considerable variety of parts. The work varies from small to large dense loads (up to 1600 lbs.) of bearing rings, balls and rolls, yet the uniform results demanded for the manufacture of precision products is constantly being achieved—and in an atmosphere of cleanliness and satisfactory working conditions."

Local Offices in every industrial center.

LINDBERG ENGINEERING COMPANY 2451 W. Hubbard Street, Chicago 12, Illinois.

LINDBERG  **FURNACES**

SAVES 10 WEEKS

WESTERN BRASS MILLS Report Savings Since Installing FULLERGRIPT BRUSHES

Western Brass Mills, Division of Olin Industries, Inc., take extreme care with the finish of their strip brass. Naturally, the brushes installed in their four pickling and annealing machines are of the utmost importance. Yet, up until 8 months ago, getting brushes that would last had always been a problem. At that time, Fullergript brushes were installed.

HERE IS HOW WESTERN BRASS NOW SAVES 10 WEEKS TIME WITH FULLERGRIPT

	PREVIOUS BRUSHES	FULLERGRIPT BRUSHES
Average Life	9 days	6 months
Replacement change per year (per pair of brushes)	30	2
Replacement time (pair of brushes)	2½ hrs.	2½ hrs.
Replacement time per year (pair of brushes)	75 hrs.	5 hrs.
No. of pairs of brushes in service	6	6
Time spent replacing brushes per year	450 hrs.	30 hrs.

TIME SAVED (per year)... 420 HOURS...OVER 10 WEEKS

In addition, Western Brass engineers estimate that the longer life of Fullergript saves them $30. on brush costs per month on each machine...an annual saving of $1440.

Have you investigated the cost-saving possibilities of Fullergript in *your* plant? For further information simply write to .....

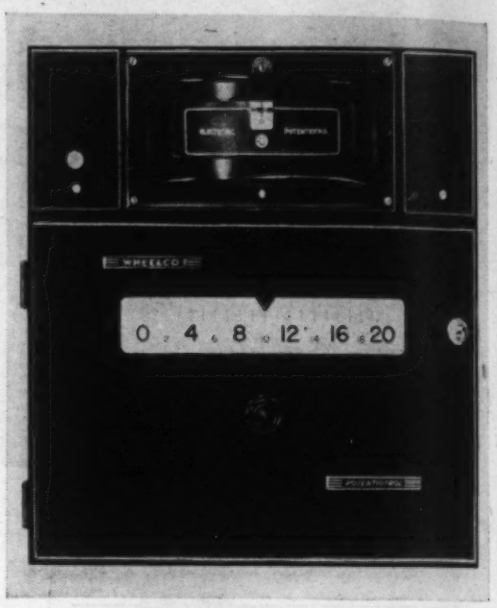
FULLERGRIPT The FULLER BRUSH CO.

INDUSTRIAL DIVISION, 3636 MAIN ST., HARTFORD 2, CONN.

New Materials and Equipment

Control Instrument

An instrument combining an electronic control circuit with a balanced or potentiometric type of measuring system is being marketed by *Wheelco Instruments Co.*, 843 W. Harrison St., Chicago 7. Called the Potentiotrol, it is recommended for installations where the use of "suppressed ranges" and a null type measuring system are desired.



Large open scale and slide wire on the Wheelco Potentiotrol afford added readability.

Measurements can be obtained with any primary element producing an electric impulse, such as thermocouples, radiation detectors, resistance bulbs, etc.

High Temperature Pyrometer

A device for measuring and controlling temperatures up to 7000 F has been announced by *Minneapolis-Honeywell Regulator Co., Industrial Div.*, 4431 Wayne Ave., Philadelphia 44. It is a modified Radiamatic pyrometer head used with an ElectroniK potentiometer.

Chief use of the instrument is expected to be in nuclear and atomic energy research and plant operation.

Tensile Testing Instrument

A new precision tensile testing instrument that makes possible the accurate load-elongation measurements of plastic and textile materials, wire, paper, rubber and adhesives

extra service for your equipment when "WEAR-RESISTED" with AIRCO hardfacing alloys

Because of the hardness and other desirable characteristics of these alloys, they provide high resistance to all types of wear—abrasion . . . impact . . . heat . . . corrosion. One application often adds 2 to 25 times longer service life to *worn or new* parts . . . big dividends in savings of "down-time" and replacements.

There is an Airco alloy available for oxyacetylene flame or electric arc application to meet all types of wear conditions.

1. Severe *abrasion and medium impact*
2. *Shattering impact and abrasion*
3. Severe *impact and abrasion*
4. *Sliding abrasion and impact*
5. *Extreme earth abrasion*
6. *Corrosion and heat*

Constant research is developing new alloys to meet special wear problems as they occur.

If you have parts or tools subject to any type of wear, it will pay you to investigate the savings you can make in maintenance and replacement costs by using Airco Hardfacing Alloys.

For further information about Airco's complete line of "wear-resistant" alloys, write your nearest Airco office or Authorized Dealer for a free copy of the Hardfacing Alloys Catalog.

More news about AIRCO products

FOR SEVERE IMPACT AND RESISTANCE TO ABRASION
Airco No. 388 Electrode

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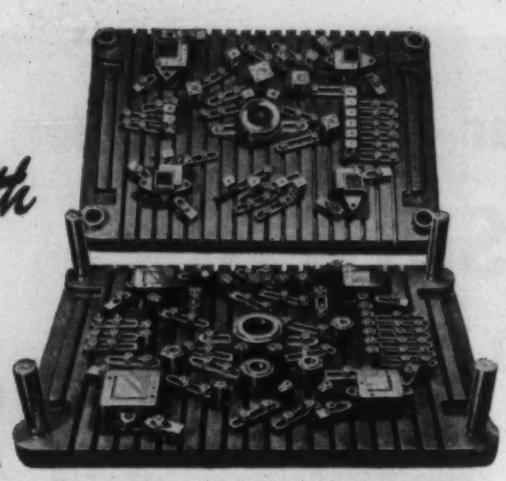

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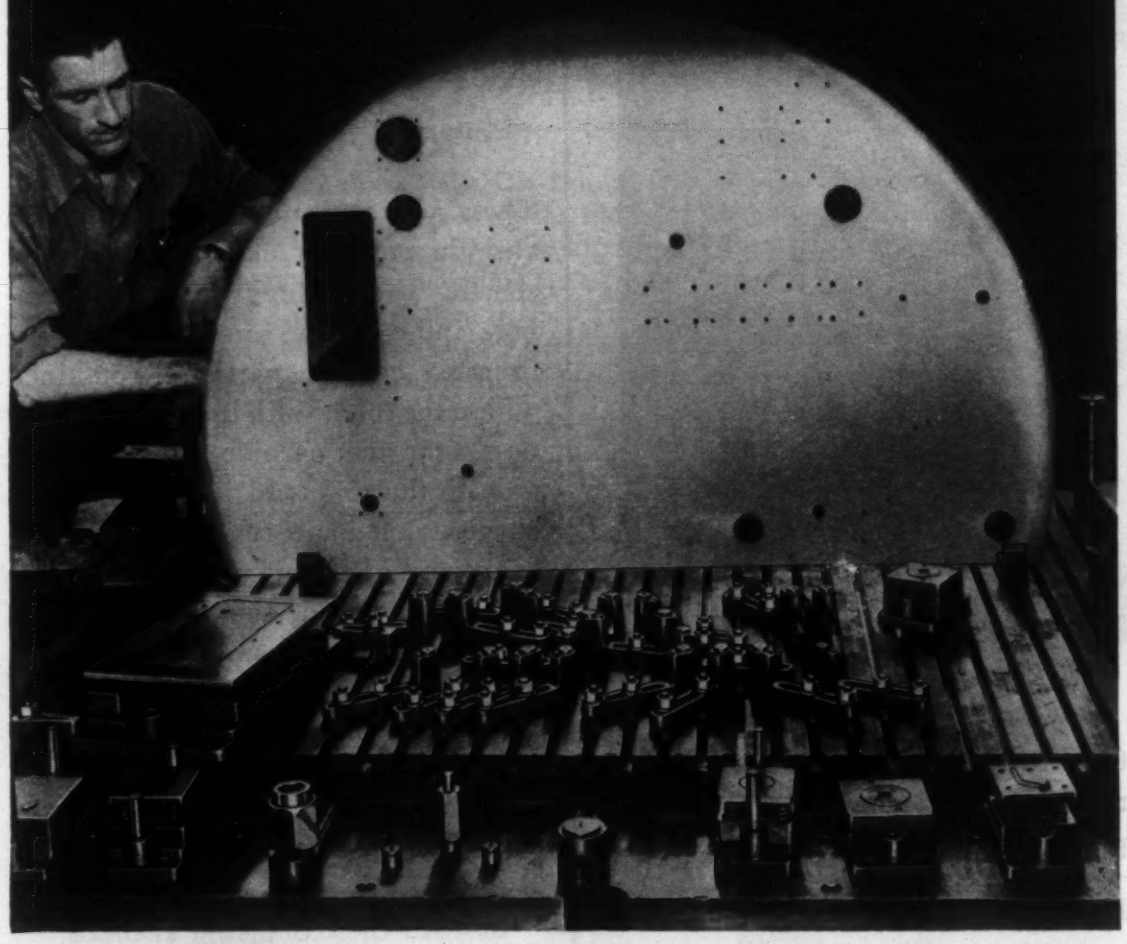

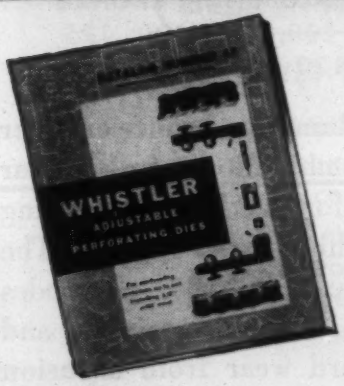

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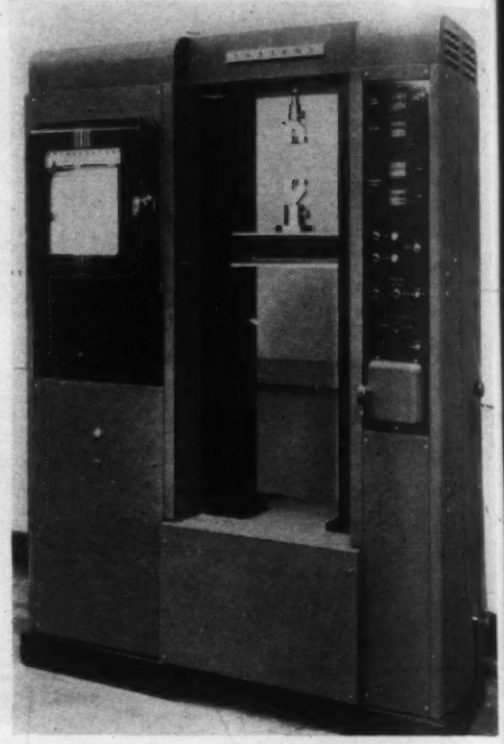
New Materials and Equipment

is now being produced by the *Instron Engineering Corp.*, 2 Hancock St., Quincy 71, Mass.

Full scale load range of the Instron Tensile Tester extends from 2 gm. to 5000 lb., while available jaw speeds range from 0.02 to 20 in. per min. Chart speeds range from 0.2 to 50 in. per min., which, in combination with available head speeds, provide magnification ratios up to 1000 to 1.



This versatile Instron Tensile Tester has a load range from 2 gm. to 5000 lb. and jaw speeds from 0.02 to 20 in. per min.

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"Extra low" test ranges on "L" type universal testing machines can now be provided by *Tinius Olsen Testing Machine Co.*, 1054 Easton Rd., Willow Grove, Pa. An electronic null system attachment can be added to any "L" machine in standard capacity up to 600,000 psi., and it operates without the necessity of stopping the test while load change is being made.

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(More News on page 112)

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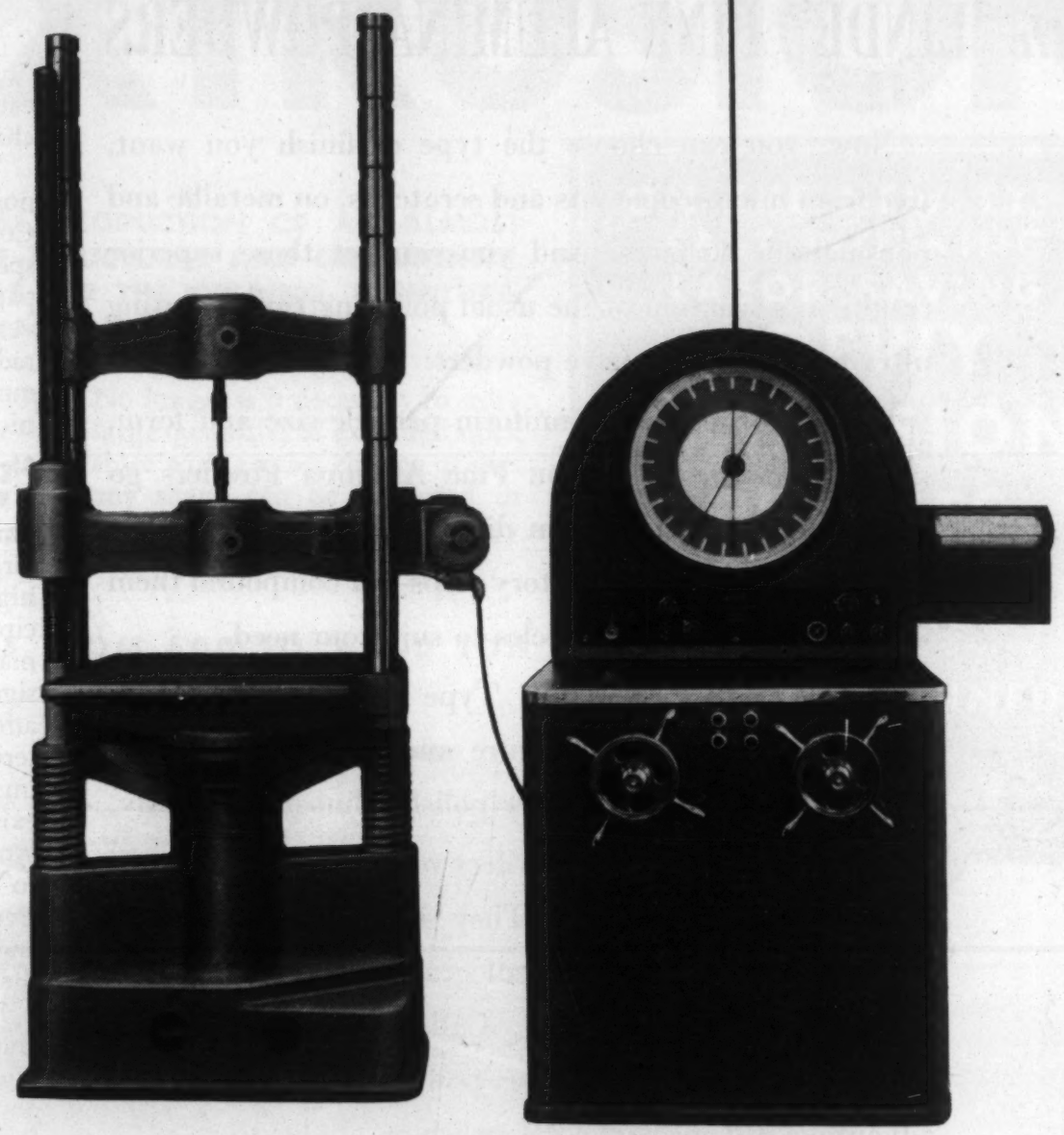

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Particle Size (approximate)	0.3 Micron	Less than 0.1 Micron
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News Digest

ASTM Papers . . .

continued from page

caused by discontinuities and those caused by magnetic permeability changes.

W. L. Schwinn covered "The Economic and Practical Application of Cobalt-60 in the Radiographic Inspection of Steel Weldments." The paper described the results of an investigation on the use of this new radiation source, Cobalt 60, and gave much practical information on techniques and costs.

Sigma Phase in Metals

One of the baffling and, until recently, generally unrecognized metallurgical changes that takes place in high-temperature alloys is the precipitation of a hard, brittle, non-magnetic solid solution called the sigma phase, which often adversely affects the properties of these materials. Considerable work is progressing on the problems created by the existence of this sigma phase, and a symposium was therefore organized to report on the progress and the trends. Eleven papers were presented and only brief mention of a few of them can be made here.

In "Some Notes on the Structure and Impact Resistance of Columbium-Bearing 18:8 Steels After Exposure to Elevated Temperatures," W. O. Binder showed that the impact resistance of 18:8 steels containing up to 2% columbium is not significantly decreased by long heating in the carbide precipitation temperature range. This good toughness is associated with the limited formation of sigma phase.

G. N. Emmanuel gave a paper, "Sigma Phase and Other Effects of Prolonged Heating at Elevated Temperatures on 25% Chromium-20% Nickel Steel," in which he reported that, somewhat unexpectedly, the room temperature tensile and yield strengths of type 310 stainless held for prolonged periods of time at elevated temperatures. However, he believes that this was probably due to insufficient sensitivity of measurements. On the other hand, the elongation and reduction of area values showed a definite decrease with increasing amounts of sigma, indicating the adverse effect on ductility.

V. T. Malcolm and S. Low in their

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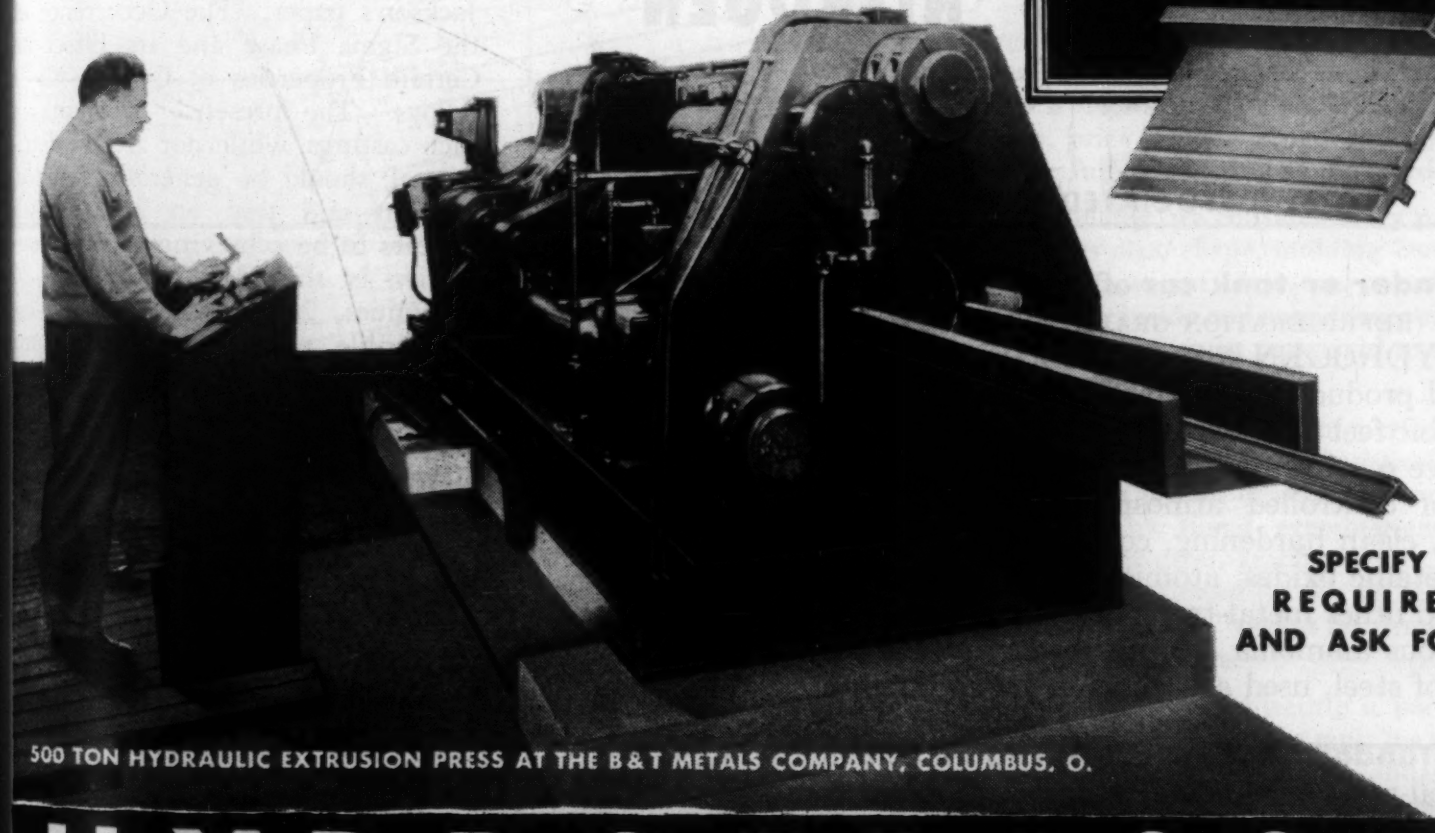

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News Digest

paper, "Sigma Phase in Several Cast Austenitic Steels," made the important point that the sigma phase problem is not a metallurgical one alone. They said that the engineer must recognize it is also a design problem.

In general, sigma phase has not been reported in iron-chromium alloys having less than 25% chromium. However, age hardening effects in alloys containing less than this percentage of chromium suggest that sigma may be present. J. J. Hegler reported that such is the case. In his paper, "The Formation of Sigma Phase in 17% Chromium Steel," he shows that by using cold work and extended heating periods at 1050 F, sigma phase is formed in type 430 stainless steel (17% chromium).

Over half of the production of heat-resistant alloy castings is in types containing sigma phase, provided the compositions of the alloys are not properly controlled, according to J. H. Jackson's paper, "The Occurrence of the Sigma Phase and Its Effect on Certain Properties of Cast Fe-Ni-Cr Alloys." The presence of sigma in such castings, while not always detrimental, should be generally avoided. Jackson said that an alloy which appears to be achieving greater popularity is the HK type (cast 26 chromium, 20% nickel). It is less susceptible to formation of sigma than the HH alloy. Of the other currently produced heat-resistant casting alloys, most contain at least 33% nickel and not over 21% chromium and are thought not to be susceptible to sigma formation.

Metals for Elevated Temperatures

As is well known, standard magnesium-aluminum-zinc casting alloys have relatively poor creep resistance at temperatures appreciably above 300 F. One of the aims of the work described by K. Grube and L. W. Eastwood in their paper, "Magnesium-Cerium Cast Alloys for Elevated-Temperature Service," was to develop casting alloys having better load-carrying capacity at 600 F. The alloy finally selected as having the best properties, had the following composition: cerium 6, manganese 0.8, nickel 0.2, and tungsten 0.02%.

Another paper by the same authors and J. A. Davis deals with "Magnesium-Cerium Wrought Alloys for Elevated-Temperature Service." The

(Continued on page 118)

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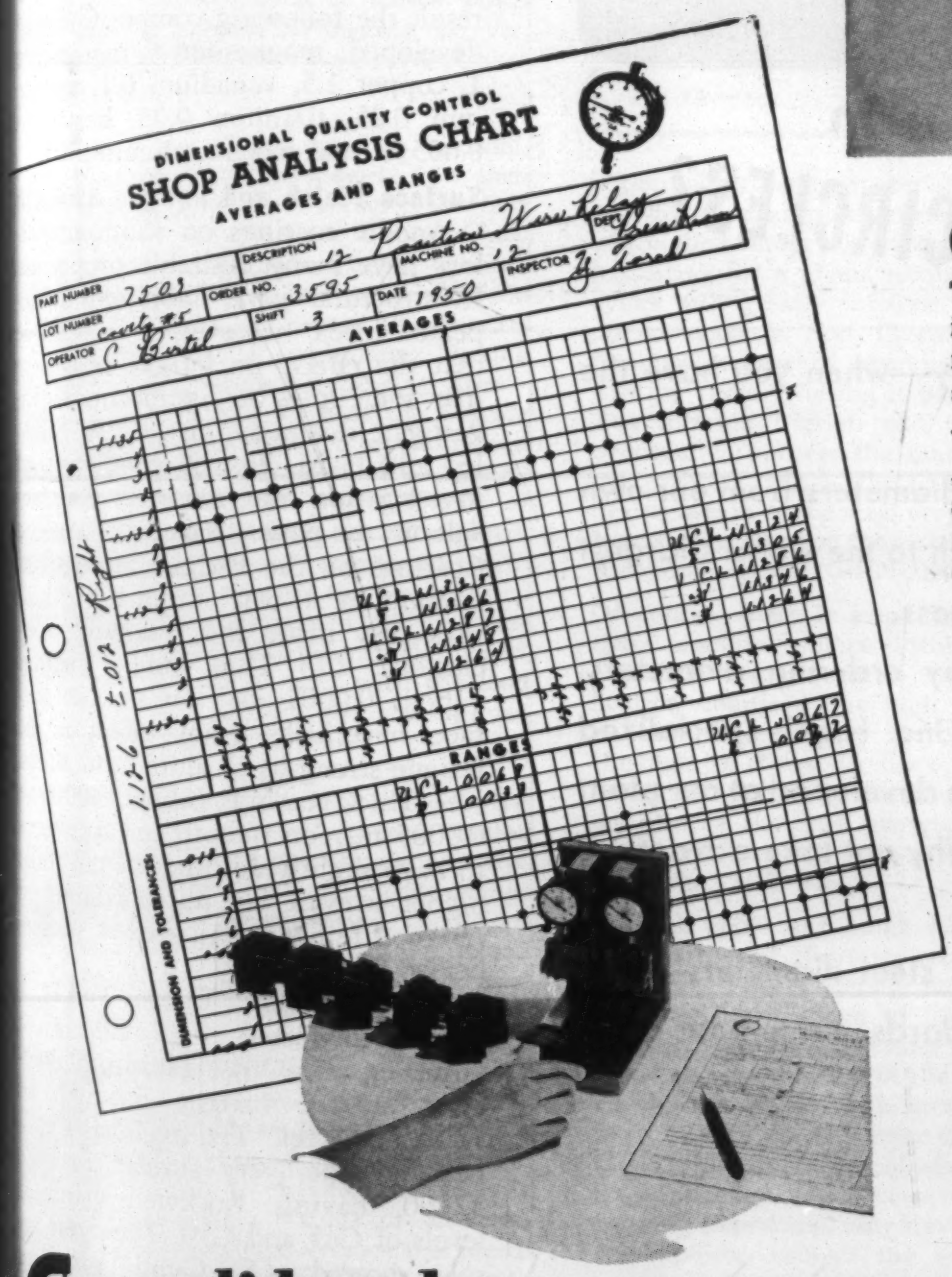

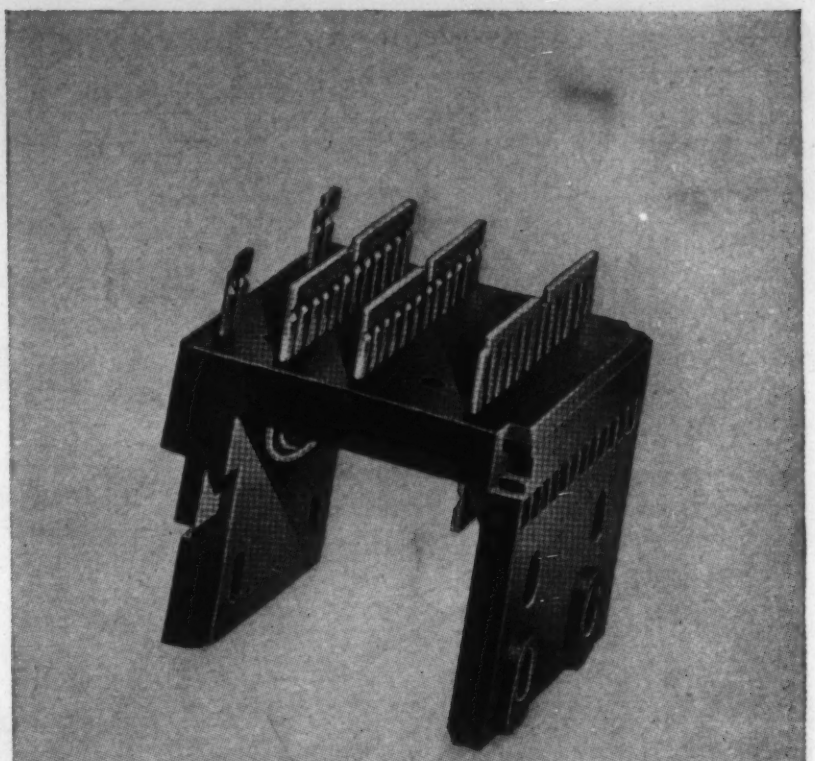

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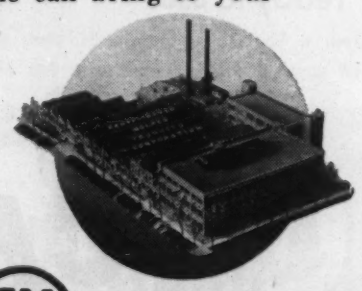

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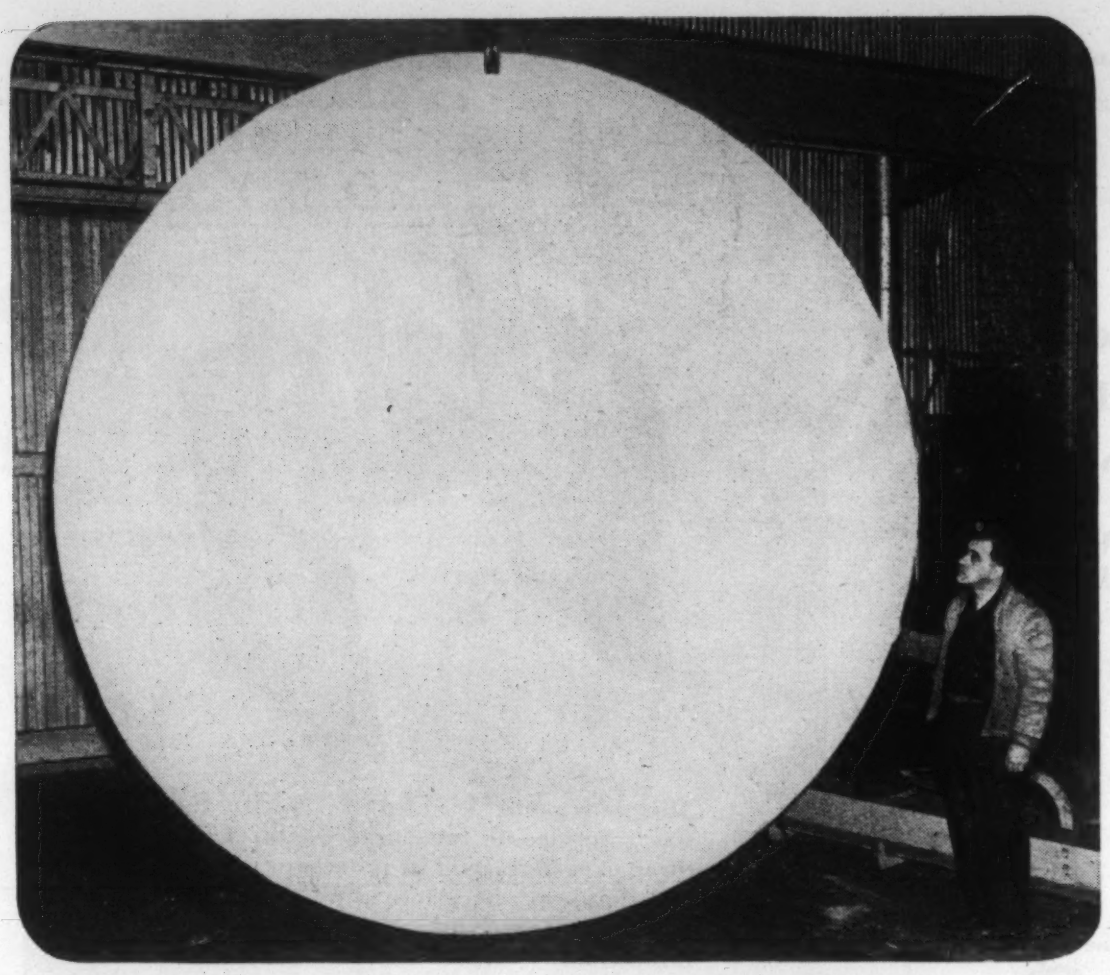

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aim here was the development of magnesium-cerium alloys having better load-carrying capacity at 600 F than three existing wrought alloys containing approximately 1.6% manganese and either 6, 4 or 2% rare earths. After a systematic study the alloy of optimum composition was found to be: cerium (rare-earths) 2, manganese 1 to 1.5, nickel 0.2%.

A third paper by L. W. Eastwood, W. Hodge and C. H. Lorig dealt with "Aluminum-6% Magnesium Alloys for Elevated-Temperature Service." The principal objective of the work was the development of improved creep properties in aluminum-6% magnesium-base alloys at 600 F. As a result the following composition was developed: magnesium 6, manganese 1, copper 1.5, vanadium 0.1, zirconium 0.25, titanium 0.08, beryllium 0.005%, and balance aluminum.

Surface Finish and Fatigue Strength

Anodic coatings on aluminum alloys have many desirable properties. In structural parts subjected to repeated loads, however, it is possible that the effects on fatigue resistance may sometimes be significant. To investigate this possibility, G. W. Stickley and F. M. Howell conducted an investigation and reported their results in the paper, "Effects of Anodic Coatings on the Fatigue Strength of Aluminum Alloys." From their findings they made the following conclusions: (1) Thin anodic coatings (about 0.0001 in.) on smooth surfaces have little, if any, effect on the fatigue strengths of aluminum alloys. (2) Thick coatings (about 0.0003 to 0.0005 in.) on smooth surfaces seem to have slightly detrimental effects at higher stresses, but no shortening of fatigue life has been noted at stresses below 12,000 psi.

A paper by L. P. Tarasov and H. J. Grover discussed the "Effects of Grinding and Other Finishing Processes on the Fatigue Strength of Hardened Steel." The steel was a ball-bearing type, very similar to type 52100, having Rockwell hardness levels of C45 and C59. Their test results showed: (1) Gentle grinding gives endurance limits as high as gentle grinding followed by careful polishing; (2) severe grinding reduced the endurance limits roughly 20 to 25%; and (3) either tumbling or shot peening after grinding greatly increased the endurance limits.

Load Carrying Capacity

THE AMOUNT of weight or force a given bearing material can successfully support per square inch of its area is known as its load carrying capacity.

In general, the load carrying capacity of a material varies proportionally to its tensile strength and hardness on which basis steel would be an excellent bearing material. However, steel does not possess the low coefficient of friction, conformability and other properties required of a satisfactory bearing material. Thus, our discussion is limited to those metals or alloys which have proven suitable for bearing use, viz; the Babbitts, Copper Lead, Aluminum and Bronzes.

To choose the proper bearing material, many factors must be considered for each particular application. Probably the first decision that must be made is that of how much space can be allotted to the bearing. In some cases there are practically no space limitations, in others the bearing area must be kept at a minimum. Having calculated the projected bearing area—the product of the length of the bearing times its inside diameter—a second design limitation, the maximum force or loading which will be imposed on the bearing at any given instant, must be determined. Often times this process is reversed—with a known maximum load, the bearing area will be partially governed by the size shafting required to transmit the generated force. In either case, with the load and loaded area known, the bearing load per square inch can be found.

The table above indicates the load carrying capacity of the most widely used bearing alloys under varying operating conditions. As can be seen, the maximum loads change 100% or more as operating conditions become more severe. In fact, as the load is doubled, the bearing life is decreased approximately ten times. Normal operation can be described as operation at a moderate range of engine speeds with intermittent stops and starts—average automotive operations. Heavy duty operation means continued high speeds and very heavy loads as obtained in a heavily loaded "high-balling" truck or an automobile operated beyond a reasonable speed. The maximum allowable load, as indicated by the short bearing life, can only be tolerated for short, widely spaced periods of operation.

The distinction is made between the so-called conventional babbitts and the thin babbitts due to the factor of relative fatigue strengths. It has been found that if the babbitt lining materials are held to a .005" maximum thickness, the load at which the bearing material will commence fracturing for a given number of loading cycles will greatly increase. The fatigue phenomenon is best illustrated by the familiar process of breaking a piece of wire by rapidly flexing it back and forth. The internal friction and cold working eventually ruptures the material. In the thin-babbitt linings, the liner follows the flexing action of the steel very closely with less working effort on the material than with the conventional .010"-.020" thickness.

LOAD CARRYING CAPACITY (in lb. per sq. in. of projected bearing area)

MATERIALS	1000 Hours Normal Operation	1000 Hours Heavy Duty Operation	100 Hours Max. Load Allowable
Conventional Babbitts Tin & Lead Base—.016 Thick	1500	1000	2000
Thin Babbitts Tin & Lead Base—.002-.005 Thick	2000	1500	3500
Copper-Lead (SAE 48)	3000	2000	4000
Aluminum Alloys	3500	2500	5500
Overlays Lead or Tin Alloy Plate	4000	2500	7000
Tin Bronzes	5000	3000	7500

Of course, there is some variation from these nominal values within the given classifications, that is as the alloy specification changes. The high lead content babbitts have slightly less strength than the high tin alloys. Similarly, with copper-leads, the softer and weaker lead phase will reduce the load carrying capacity of a 25-30% lead alloy much below that of one with 5-10% lead.

Another important design consideration is that of the oil clearance required by the material. The tendency for copper-lead and aluminum alloys to "Seize" on the shaft requires that a greater space be provided than in the case of the babbitt. The clearance requirement is increased further in the case of the aluminum due to its very high coefficient of thermal expansion. Thus, an application which requires very close running clearances, may have to fall back on babbitts, though the imposed loads would tend to dictate the use of the higher capacity materials.

On the other hand, a relatively low load application operating in or near high heat may force the designer to use aluminum or one of the tin bronzes.

In the case of the overlay bearing—that is a copper-lead bearing material plated with a lead-alloy (.0005"-.002" thick) the load carrying capacity is appreciably increased. The exact manner in which the soft lead alloy affects the increase is not completely understood. However, the results of many tests indicate that the protection afforded the shaft and base bearing material during the critical break-in period is a very important factor. It is felt by many that the distress incurred in the first few hour's running determines the bearing's success or failure. Once the high spots are worn in and the minor misalignments are accommodated, the bearing, if still in good shape, will pile up long hours of successful operation.

The selection of the bearing material to be used cannot be made on the basis of only one desirable property. A tendency to corrode will rule out some materials; low fatigue strength disqualifies others; and the economic factor may prohibit still others. In brief, Load Carrying Capacity, like all the other properties of the various bearing materials, must be considered thoroughly in the light of all the design factors involved in the application at hand.

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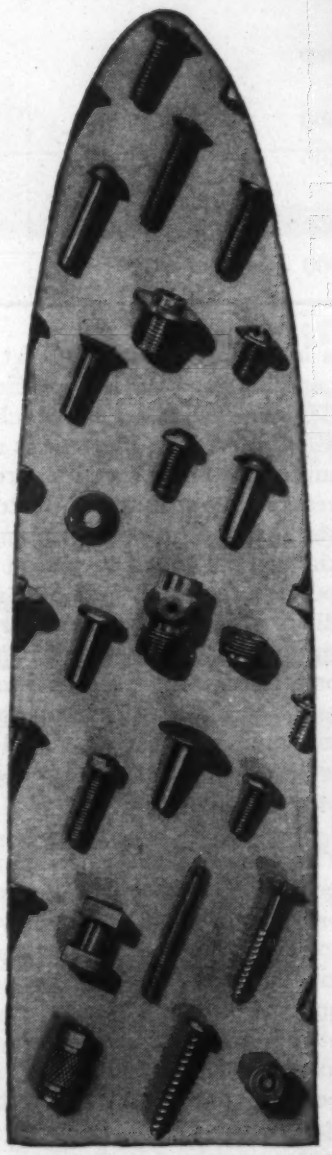

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News Digest

Plastics Conference

continued from page 9

Durability of Plastics

In "Resistance of Plastics to Various Service Conditions," G. M. Kline, National Bureau of Standards, summarized the results of several investigations carried on by Bureau scientists.

Of the accelerated weathering tests employed, the most severe proved to be alternate exposures of 24 hr. at 175 F at both 95 to 100% and less than 5% relative humidity. Under these conditions, all plastics tested, except the phenolic reinforced with asbestos fabric, increased in thickness. The phenolic increased in both flexural strength and flexural modulus of elasticity. Next to the phenolic, a glass-fabric unsaturated polyester laminate showed best resistance.

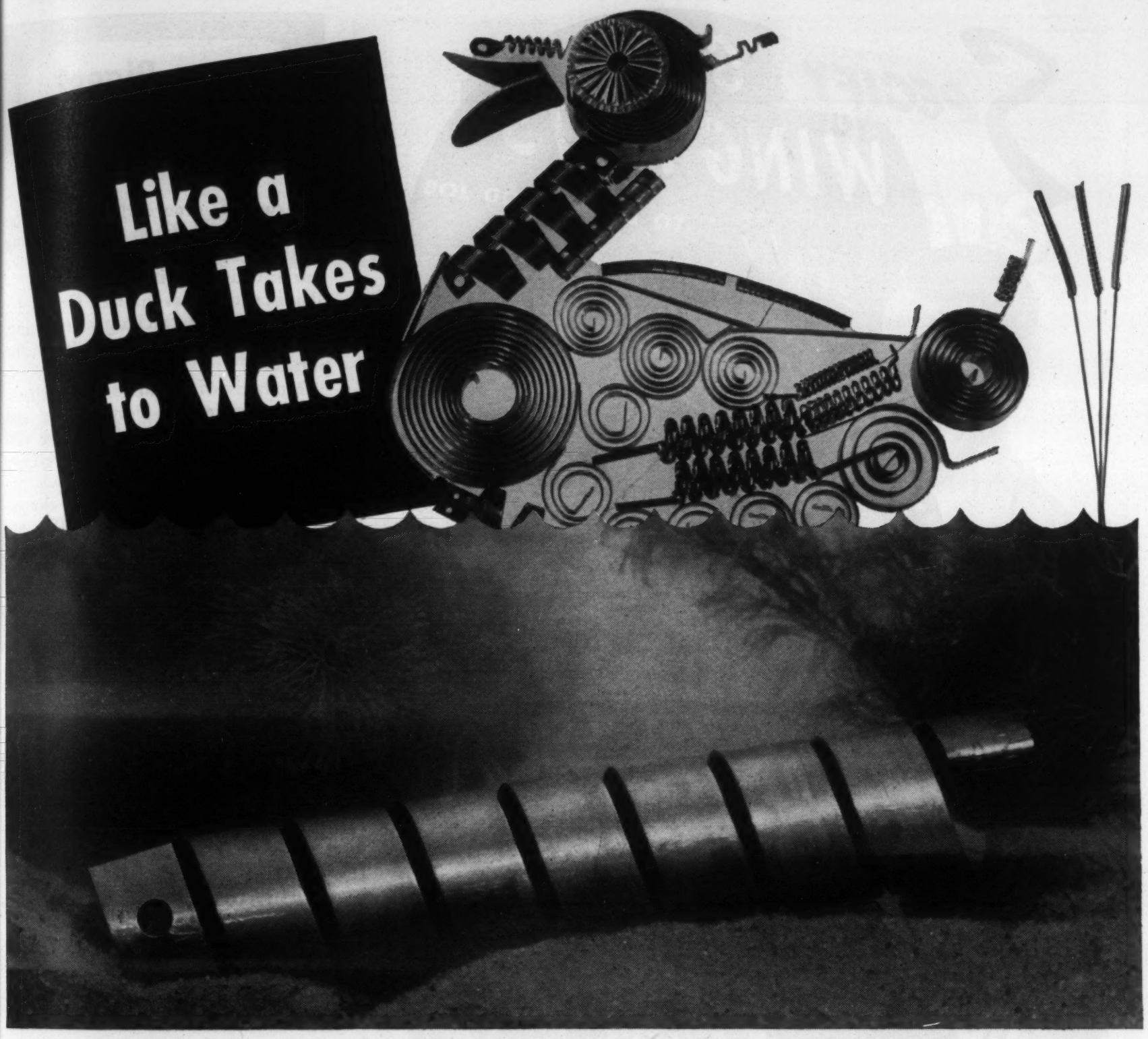
After immersion in heptane, toluene and a representative aircraft test fuel, the glass-fabric unsaturated polyester laminate demonstrated best weight and dimensional stability. Losses in flexural strength after 360 days immersion were less than 10% except for some unsaturated polyester laminates. The same held true for modulus of elasticity, except that a phenolic laminate was also affected by more than 10%.

Polymethyl methacrylate, polystyrene and cellulose acetate butyrate were only slightly affected by light, whereas ethyl cellulose showed some yellowing and crazing, and polyvinyl chloride acetate was erratic. Only polyvinyl chloride showed considerable shrinkage upon heating 24 hr. at 150 F. Subjected to a combination of moisture, heat and ultra violet light conditions, the asbestos-fabric phenolic laminate and the glass-fabric unsaturated polyester laminate proved most stable.

Defects in Molded Parts

Some of the defects which occur in molded plastic parts were discussed by R. S. Spencer, Dow Chemical Co., in his paper "Injection Molding of Polystyrene."

Sink marks and bubbles, common defects resulting from thermostatic stresses set up in cooling, can be avoided by keeping pressure on until a later stage of cooling is reached. Other surface blemishes are gas burns, caused by compression of entrapped air; grooves, formed when two streams do not join completely; scor-



Truflex J7 THERMOSTAT METAL Resists Water Corrosion

General Plate Truflex J7 Thermostat metal takes to water like a duck. For instance, the coil shown above has operated in a hot water tank over 8 years, yet not a single spot in the metal showed corrosion.

In addition to the application above, Truflex J7 Thermostat metal is operating successfully without corrosion in such applications as water mixing valves (shower mixing valves), hot water temperature measuring valves, tanning applications which often require operation in mild acids, radiator valves, etc.

Truflex J7 is but one of the many thermostat metals manufactured to meet specific requirements by General Plate. In fact, Truflex Thermostat metals are available in a complete line of combinations to meet all applications in temperature range, electrical resistance, size, shape and cost. They can be had in raw stock in sheets and coils . . . or as completely fabricated parts ready for assembly into your products. Each and every part is identical in tolerances, expansion, hardness, etc.

It will pay you to investigate General Plate Truflex Metals for your thermostat requirements. Write for information or engineering assistance.

Other General Plate Products Include — Precious to base metal laminations . . . Base metal laminations . . . Alcuplate (copper and aluminum) . . . silver solders . . . Laminated contacts, buttons, rivets . . . Platinum-fabrication-refining . . . Age-hardening Manganese Alloy 720.

GENERAL PLATE

Division of Metals and Controls Corporation

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SPECIFY GRC WING NUTS
1. TO DO A GOOD JOB
2. LOOK BETTER
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GRC offers quick service and low cost on strong, good-looking wing nuts of rustproof zinc alloy. All commercial finishes, all popular thread sizes. Wing nuts with special threads or untapped wing nuts also available. Inquiries invited for special wing nut designs.
Write today for samples and prices
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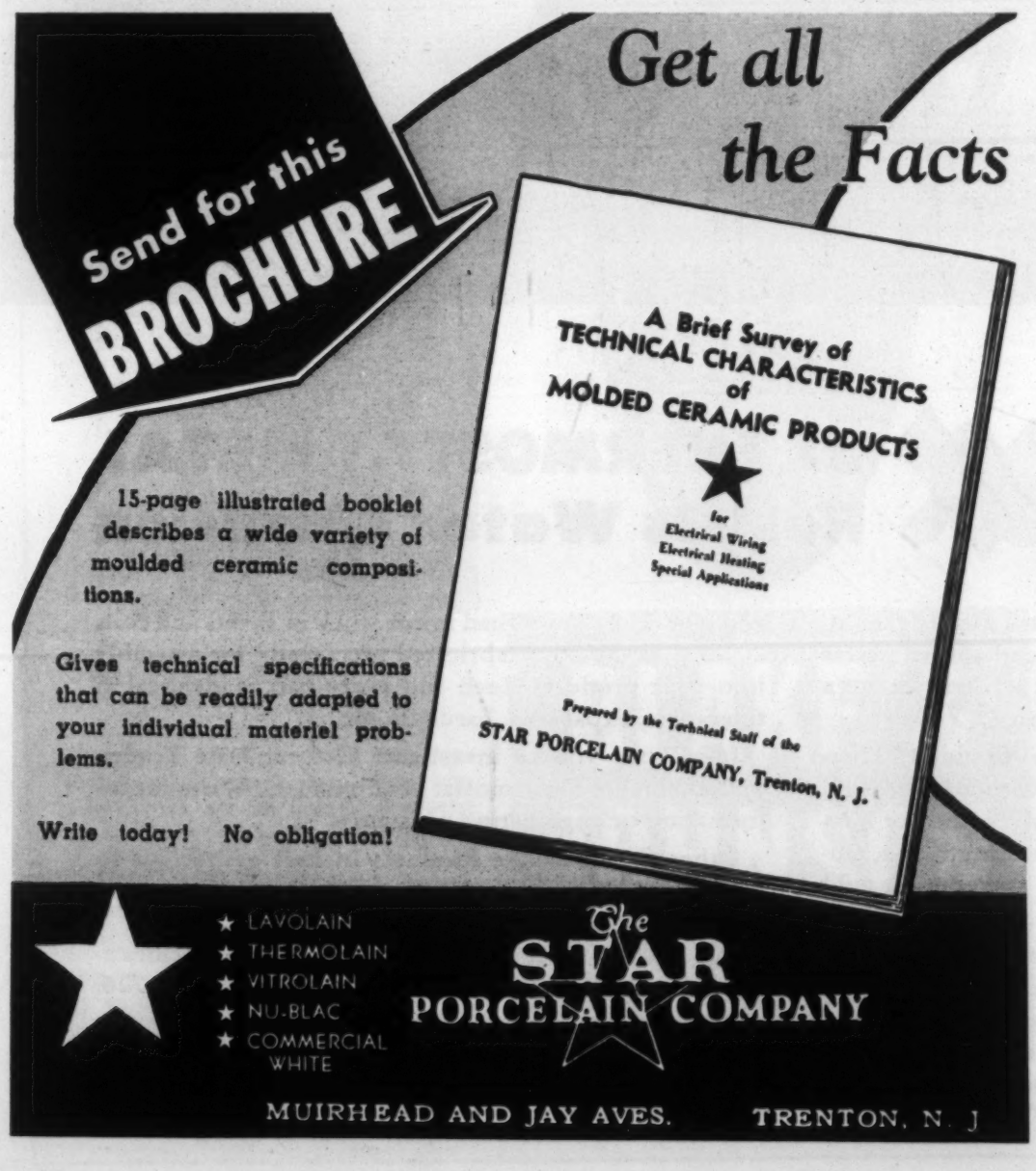
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Get all the Facts
A Brief Survey of TECHNICAL CHARACTERISTICS of MOLDED CERAMIC PRODUCTS
for Electrical Wiring Electrical Heating Special Applications
Prepared by the Technical Staff of the STAR PORCELAIN COMPANY, Trenton, N. J.
15-page illustrated booklet describes a wide variety of moulded ceramic compositions.
Gives technical specifications that can be readily adapted to your individual materiel problems.
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News Digest

ing, which occurs during ejection from the mold if too high a molding pressure has been used; ribbon-like marks, caused by incomplete bonding of initial material squirted into mold; and crazing or cracking after aging, resulting from residual strains in the part.

Methods of "Evaluating Mechanical Properties of Polyethylene and Other Nonrigid Plastics" were discussed by R. H. Carey, Bakelite Div., Union Carbide & Carbon Corp.

The author showed that elongations as high as 300 to 400% are achieved only under ideal conditions of uniaxial stressing. He asserted that polyethylene is actually not a "rubber-like" or "elastomeric" material but more nearly resembles some nonferrous metals. This comparison was based on the crystalline nature of polyethylene, its stress-strain diagram and stress corrosion phenomena.

Not Enough Research

An indication that there is some disagreement on the place of research in small industries was afforded by G. H. Clark, The Formica Co., in his talk on "Plastics-Based Laminates." He asserted that the plastics-based laminates industry could not afford the research on resins that should be carried out in order to improve and expand this field of application. His stand was disputed privately by several engineers, who believe that research is not a luxury but a necessity for fabricating industries.

L. S. Meyer, Western Products, Inc., provided a change of pace by exhibiting and explaining some 25 different examples of reinforced plastics produced at low pressures. The low-pressure laminated products, based on glass fiber or glass mat, included a fishing rod, tote box, outdoor lamp shade, safety helmet and washing machine tub.

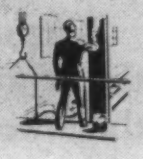
High Standards Pose Problem

Rising standards of product quality demanded by industrial purchasers and the general public are making rejections and returns a serious problem for producers, according to Joseph Manuele, Westinghouse Electric Corp. Speaking at the Company Member Conference of the American Standards Assn., May 17 in Pittsburgh, he estimated that rejections are

News about

UNICHROME
Trade Mark

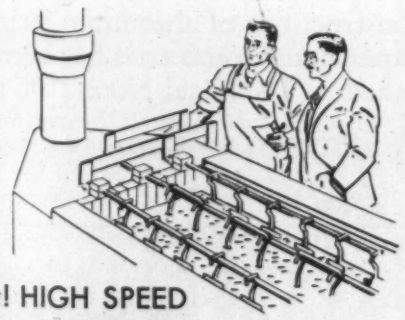
COATINGS for METALS



Chemical-resistant coatings in the heavy-duty class

Unichrome Plastisol and Organosol Compounds "4000 Series" possess a set of properties seldom found in *one* material. (1) They have the greater resistance of the vinyls to chemicals, oils, water. (2) This resistance is further increased by the *thick* coatings—up to 3/16" —that they produce. (3) And because they have *flexibility*, they withstand mechanical damage as well. (4) They are applied by dipping or spraying.

Here may be your answer for protecting lighter or less costly metals from strong chemical corrosion. Consult "Coatings for Metals" headquarters for more information.



What! HIGH SPEED chromium plating?

The most important advance in chromium plating in 20 years, Unichrome S.R.H.S. Chromium plates faster than conventional solutions — in some cases cutting time in half. It also plates bright over a wider current range — assuring less "burning" and "missing" on irregular parts. Its self-regulation insures a more foolproof bath with less supervision.

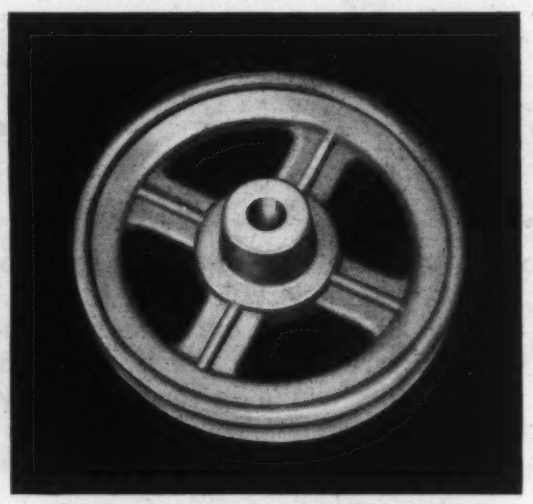
New primer for magnesium and aluminum

Hard-to-coat metals such as magnesium and aluminum get a finish that really sticks when coated with Unichrome Primer AP-10. Not only does this organic primer promote adhesion, but it also provides extra corrosion-resistance and increases durability of top coats used.

How to get a QUALITY finish at an ECONOMY price

Extra bright, durable finish on zinc plate...
Extra corrosion-resistance for zinc die castings...
provided at a low, low cost by **UNICHROME DIP PROCESS**

Sparkling rust resistance at low cost for wire goods and small parts obtained with zinc plate and Unichrome Dip.



Chromate treated in Unichrome Dip, zinc die cast parts resist corrosion with a yellowish to olive drab finish.

Zinc plate followed by the Unichrome Dip process works wonders on sales appeal and finishing costs. The ordinary zinc gains chromium-like brightness. Some users have reported it the brightest dip finish they've *ever* seen. And it stays bright. For Unichrome Dip Finish adds corrosion-resistance—protects the zinc against dulling.

Yet this kind of finish costs you only a fraction of a penny per square foot of average zinc surface treated. Therefore, you can see why Unichrome Dip Finish is being used extensively on zinc die castings, refrigerator shelves, wire goods, screws, nuts, bolts and other parts.

The Unichrome Dip process is a chemical treatment. The finish it forms is integral with the zinc surface. It can also be used to chromate-treat unplated zinc die castings. Such chromate treating produces a yellow or olive drab coating with corrosion-resistance even greater than that obtained with the bright finish—again at rock-bottom cost.

We'll gladly send you more information on Unichrome Dips. And remember, if you have a problem in metal finishing, chances are you can find a solution at "Coatings for Metals" headquarters.

UNICHROME
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HOW THE WROUGHT BRASS INDUSTRY CONSERVES METAL

No industry melting *commensurate tonnage** of vital metal can quite match the brass mills for conservation and low melting losses. The savings of metal total millions of pounds; clearly the method they use is worth noting:

Virtually all the brass mills in North America use the Ajax-Wyatt induction melting furnace, for it has the lowest metal losses in the field — less than 1% — with superior temperature control and unapproached economy of operation on high production schedules such as we have today.

The accepted melting tool in brass rolling mills throughout the world.

* *Upwards of 5 billion pounds annually.*

AJAX ELECTRIC FURNACE CORP.

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THE AJAX WYATT INDUCTION MELTING FURNACE

ASSOCIATE COMPANIES: AJAX METAL COMPANY, *Non-Ferrous Ingot Metals and Alloys for Foundry Use*
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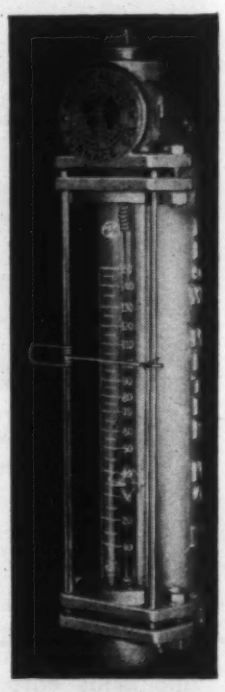
AJAX ELECTRIC COMPANY, INC., *The Ajax-Hultgren Electric Salt Bath Furnace*
AJAX ENGINEERING CORPORATION, *Ajax-Tama-Wyatt Aluminum Melting Induction Furnaces*

FLOW METERS*



A visual, continuous indication of flow rate is provided by A.G.F. Flow Meters. Rate of flow is read directly in cubic feet per hour. Any change or interruption in the flow is immediately evident. Units are available for practically all gases used in industry, and many liquids. Gas capacities range from ¼ to 3000 cubic feet per hour.

A.G.F. Flow Meters give an accurate, dependable reading at all times and insure uniform results by permitting duplication of previously determined settings. The patented alloy center-wire construction keeps the float permanently centered in the glass tube, and helps to damp oscillations resulting from minor variations of flow or pressure.

Many applications—A.G.F. Flow Meters are used for the measurement of the flow of atmosphere gases of all kinds, including carburizing gases, ammonia flow in Nitriding, hydrogen flow; and measurement of the flow of fuel gases, including city gas, natural gases, bottled gases such as butane and propane, and mixtures of gas and air.

*** Patented**

Write for new catalog No. C-1303, describing Flow Meters and other A.G.F. products including gas carburizers, heating machines, oven furnaces, pot furnaces and other heat-treating equipment.

AMERICAN GAS FURNACE CO.

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News Digest

now costing American industry three billion dollars annually.

Excessive costs of rejections and returns emphasize the value of mutual protection given by clearly defined, understandable and measurable standards of quality, such as those established by the American Standards Assn., Manuele said.

Diamond Dust Polishing

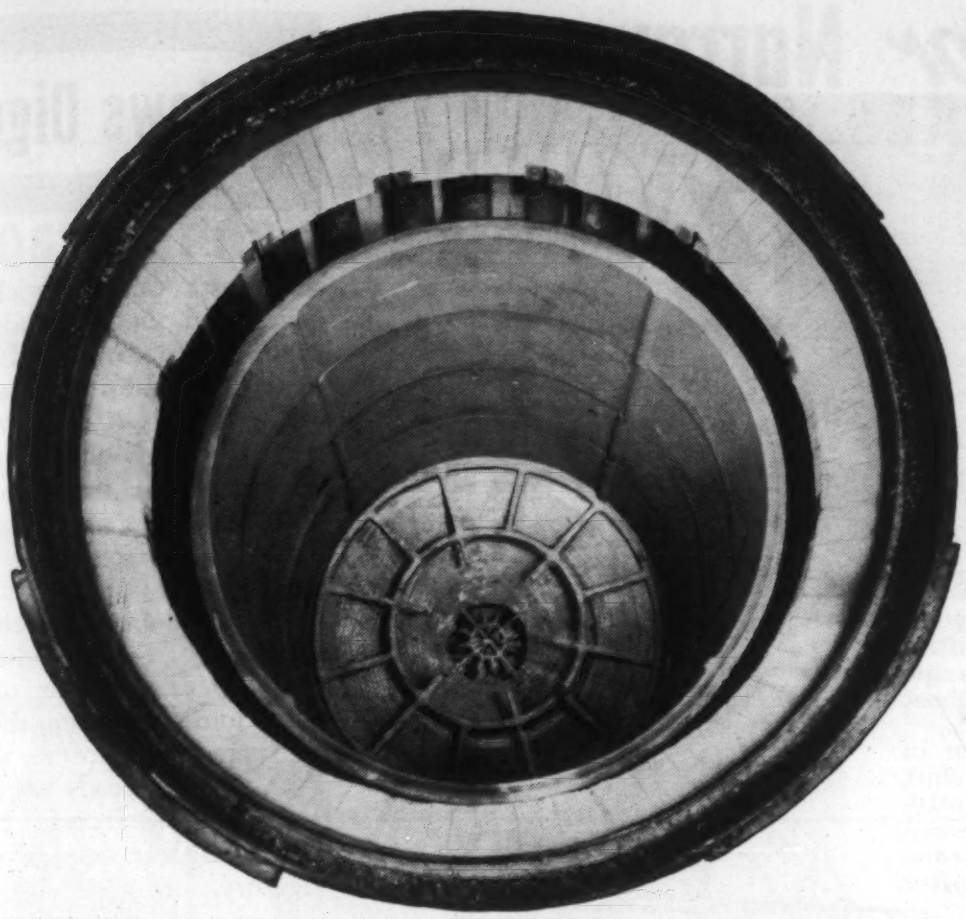
Use of diamond dust for polishing metallographic specimens of nonferrous metals and alloys was described by E. C. W. Perryman in the March 1950 issue of the *Journal of the Institute of Metals* (British). Substitution of fine diamond dust for the usual coarse polishing agents is said to reduce total polishing time and to reduce the relief between coatings or phases differing widely in hardness.

Adhesives, Bonding Processes for Sandwich Materials Studied

An evaluation of several adhesives and processes for bonding sandwich constructions of aluminum facings on paper honeycomb core has been published as Technical Note 2106 by the National Advisory Committee for Aeronautics.

Near the end of the war, sandwich constructions consisting of high-strength facings bonded to opposite faces of a low-density core material were being extensively investigated for use in aircraft construction. Original emphasis in this development was on the use of balsa wood and foamed plastics as core materials. More recently, sheet metal, resin-impregnated paper, and resin-impregnated cotton and glass fabrics prepared in the form of honeycomb structures have been developed as low-density core materials for use in aircraft sandwich constructions. However, certain problems have arisen in bonding facings to these honeycomb core materials because of the small area of actual contact for bonding and because the large cells tend to entrap adhesive solvents and to produce blistering when panels are hot-pressed.

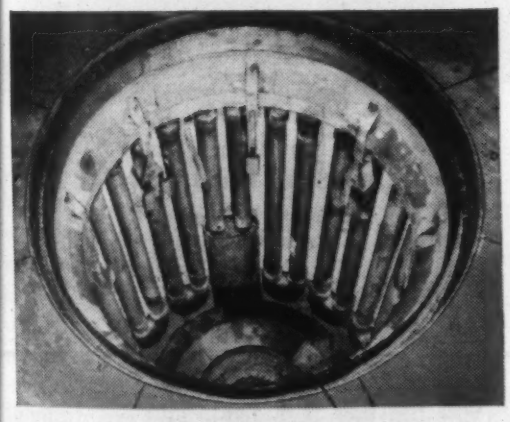
In this investigation, six of 14 bonding processes evaluated by ten-



Pit-type furnace with all-Inconel radiant tube assembly. Designed and built by Surface Combustion Corporation, Toledo 1, Ohio.

With Surface Combustion Corporation, too—

"It's INCONEL for longer-lasting furnace equipment!"



A pit-type furnace with an Inconel atmosphere generator sheath. The Inconel sheath was still in good condition after 17 months of service despite severe operating conditions. Manufactured by Surface Combustion Corporation, Toledo 1, Ohio.

They tried Inconel® first in an atmosphere generator sheath . . . exposed to a controlled atmosphere and severe temperature.

17 months later, when the furnace was overhauled, they found the Inconel sheath still in good condition.

Impressed by this performance, Surface Combustion Corporation engineers ordered all-Inconel radiant tubes installed in a pit-type gas carburizing furnace. The fabrication job was not difficult because Inconel is readily available in seamless extruded *thin-walled* tubing and fabricated return bends.

The tubes were assembled to the return bends by welding... practical because welds in Inconel are as heat- and corrosion-resistant as Inconel itself.

Like Surface Combustion, many other large makers of heat-treating equipment have turned to Inconel for extra service life and lower maintenance costs. Inconel has long ago established itself as one of the most durable high-temperature metals available at any price. Exposed to temperatures of up to 2200° F., Inconel resists corrosion, embrittlement, and destructive oxidation.

For further information about fabricated Inconel radiant tube assemblies, write directly to INCO. Your nearest INCO distributor will gladly quote on stock Inconel mill forms.

THE INTERNATIONAL NICKEL COMPANY, INC.
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INCONEL . . . for long life at high temperatures

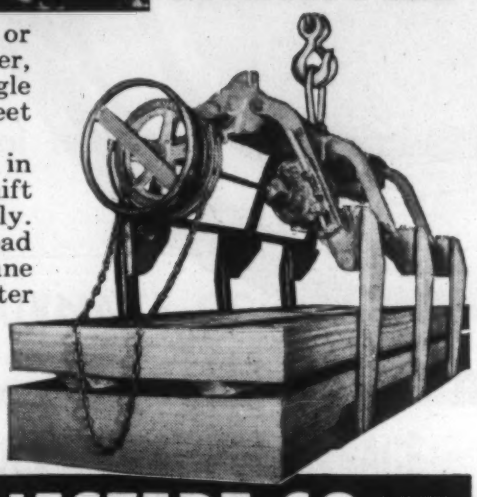
Wide *or* Narrow...

1 C-F LIFTER HANDLES THEM ALL

Whether your production requires a few or many widths of sheet steel, 1 C-F Lifter, with its wide range of jaw and carrying angle adjustments will probably meet all your sheet handling requirements.

Adjustments are made by the operator in a few seconds, permitting the Lifter to shift from wide to narrow sizes almost instantly.

Because it can pick up, carry and unload more loads per hour, using less man and crane time than any other method, a C-F Lifter will soon pay for itself.



Bulletin SL-25 gives you the complete story of C-F Lifter advantages to you. Ask for it today. There's no obligation.

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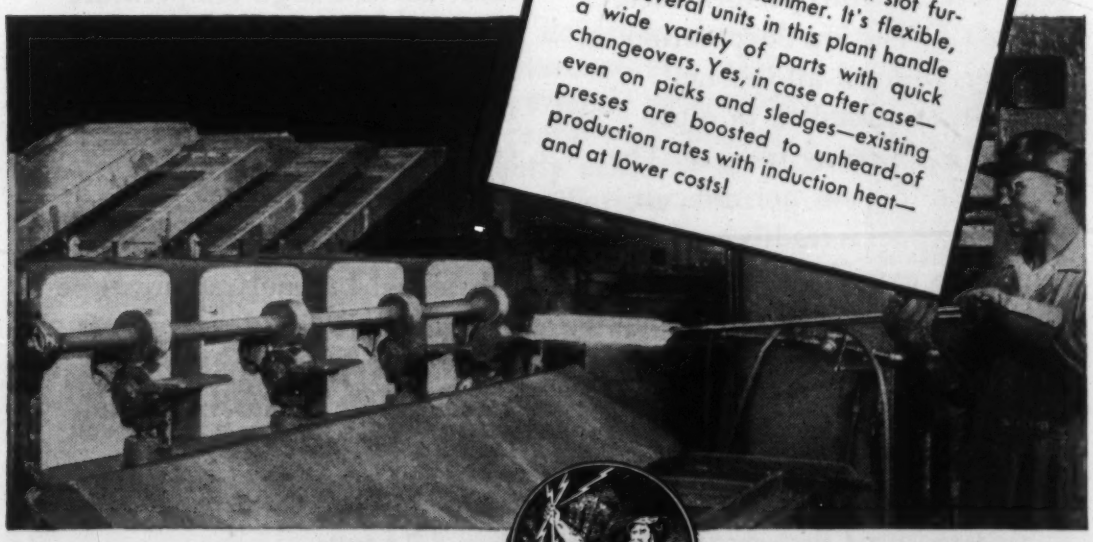
AND BOOSTS PRODUCTION

40%

Every hour this induction heating unit automatically feeds 600 hot connecting rod billets into the tongs of the operator. By virtue of its speed, its split-second control over time and temperature, and its scale-free heating, it gives 40% greater over-all production than the best of other furnace-press combinations considered—four times the rate possible with slot furnace and drop hammer. It's flexible, too. Several units in this plant handle a wide variety of parts with quick changeovers. Yes, in case after case—even on picks and sledges—existing presses are boosted to unheard-of production rates with induction heat—and at lower costs!



Ask for the scores of ideas in Induction Heating Bulletin 13-A

SINCE 1916

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HEATING & MELTING

News Digest

sion tests on sandwich specimens gave good-quality bonds which had average strengths of 350 psi. or more than 75% failure in the core when tested at both 80 and 200 F.

The four bonding processes that had given the best results in these preliminary tests were used in a further investigation made to determine the effect of the amount of adhesive spread on the tensile strength of the joints. All four bonding processes were found capable of producing good joints between the aluminum and paper honeycomb when moderately heavy spreads were applied to both wire and facings. For some adhesives, lighter spreads appeared satisfactory.

Plastics Engineers to Meet

"Plastics Shape the Future" will be the theme of the Seventh Annual National Technical Conference of the Society of Plastics Engineers, Inc., to be held Jan. 18 to 20 in New York City.

Sponsored jointly by the New York and Newark sections, the conference will be open to all persons in the plastics and allied industries. Further information can be obtained from the Society, 386 Fourth Ave., New York.

News of Engineers

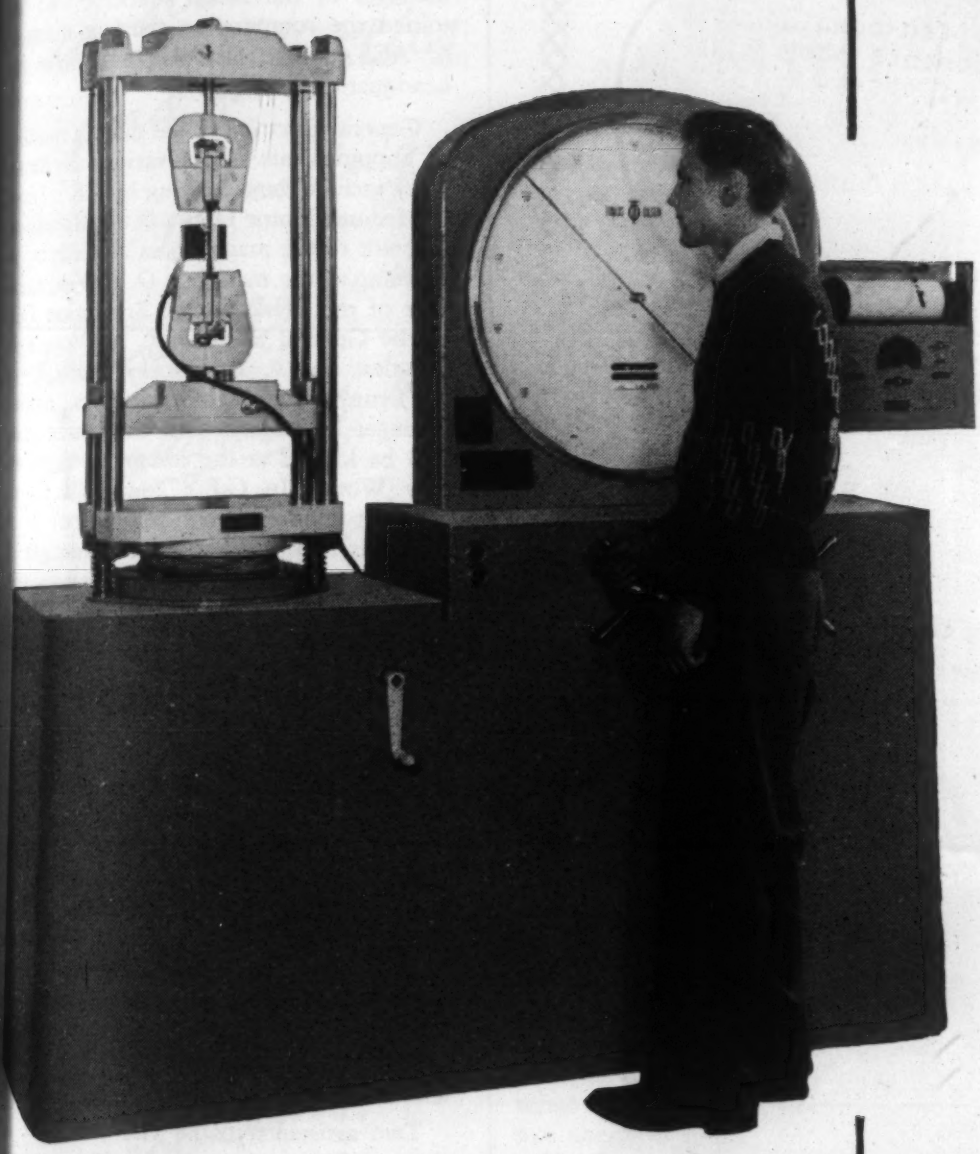
George I. Bottcher, assistant chief engineer of Allegheny Ludlum Steel Corp., was recently promoted to the position of chief engineer. Simultaneously, *J. F. Chapman* and *R. E. Smith* were named as assistants to the chief engineer. Mr. Chapman will be in charge of design and construction engineering, and Mr. Smith will retain his duties of office manager and will supervise the procurement and expediting of materials. All three appointees will maintain headquarters in the company's general offices at Brackenridge, Pa.

The Wall Colmonoy Corp. has announced the addition to its staff of *R. L. Peaslee* as development engineer. Mr. Peaslee, formerly metallurgist for the Wright Aeronautical Corp., will also head the Alloy Brazing Dept. of the company.

Orlo E. Brown, previously chief metallurgist for Western Gear Works, has joined the Robertshaw-Fulton Controls Co. as research metallurgist.

American Car & Foundry Co. has ap-

THE MOST IMPORTANT ADVANCE IN TENSION AND COMPRESSION TESTING!



Widest spread of capacities in one machine—0 to 60,000 lbs.; 0 to 12,000 lbs.; 0 to 1200 lbs. A 50 to 1 ratio. Additional lower ranges available.

When equipped with an Olsen Recorder, recorder load scale ranges are 100 to 1 minimum.

Selec Φ range Indicating System **with (atcotran) Unit**
Choose any of the ranges at the flip of a switch. All zeros identical.

Load ranges can be changed under test.

28″ diameter dial with ultra-precision uniform graduations. All ranges are on one easy-to-read dial.

Automatic, fool-proof range indicating system for showing the range in use. Each range individually lighted.

Simplified Controls.

Larger capacities available up to 400,000 lbs.

Accuracy in all ranges within ASTM, U. S. Army, Navy, and Federal Specs.

And in addition, low cost.

The New Olsen Hydraulic SUPER "L" Universal Testing Machine

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NEWS on NYLON Molding

Our new molding technique permits us to state unequivocally that:

1. Nylon parts cost less (often considerably less) than metallic components they replace in the majority of cases.
2. Die costs are not expensive.
3. Small runs are possible at a reasonable price.
4. Our prices on large runs are definitely competitive.

We offer the assistance of our research engineers to help solve your problems in connection with Nylon Molding.

If you are not now using Nylon, our product study service is available. Possibly we can show you how advantageous Nylon Molding can be with our methods and equipment.

SCHAEFER-HAUSER MOLDING CORP.

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. . . provides extensive facilities, plus engineering skill, to solve any type of fabricating problem involving modern industrial metals. Spinning of large diameter, deep-drawn or polished forms is a PHOENIXSPUN specialty. Your specifications and prints will bring our prompt estimates.

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News Digest

pointed *Ralph F. Koeneman* chief engineer of passenger car engineering at ACF plant in Berwick, Pa. Mr. Koeneman has been assistant chief engineer of the same department. It was also announced that *John C. Coonley,* formerly assistant works manager of the Heald Machine Co., has joined the company as assistant manager of ACF's Valve Div. He will make his headquarters in Detroit.

General Electric Co. has made a number of appointments in its various divisions. They include the following in G.E.'s Small & Medium Motor Divs.: *D. E. Moorhead,* assistant to the manager, as administrative assistant to the manager; *O. F. Vea,* manager of the Marketing & Promotion Div. in the General Sales Divs., now manager of sales; and *F. B. Hornby,* manager of the Lynn Motor Engineering Divs., named manager of engineering. All three men will be located at the company's Schenectady Works. In G.E.'s Apparatus Dept., three promotions were announced: *J. P. Keller* is now assistant to the manager of the Industrial Divs.; *L. E. Newman,* formerly assistant manager of G.E.'s Lynn (Mass.) Turbine & Gear Sales Div., succeeds Mr. Keller as superintendent of all generator and turbine bucket manufacturing for the Turbine Divs.; and *Floyd C. Pickett,* works superintendent, was named assistant to the works manager of the Fitchburg Works. Dr. *Lewi Tonks,* physicist in G.E.'s Research Laboratory, was appointed head of the Physics Div. in the Knolls Atomic Power Laboratory, which G.E. operates for the Atomic Energy Commission. And finally, *James L. McFarland* was named manager of engineering of G.E.'s Industrial Heating Engineering Div. Mr. McFarland previously was assistant division engineer of the Division.

Two assistants to the vice president in charge of operations of the Youngstown Sheet & Tube Co. were named recently. They are *William H. Yeckley,* formerly general superintendent of the Campbell Works steel plant, blast furnaces and Struthers works, and Dr. *Karl L. Fetters,* previously special metallurgical engineer.

Dr. *Paul M. Erlandson,* a specialist on guided missile and anti-submarine instruments, has been appointed chairman of Southwest Research Institute's Physics Dept. Prior to assuming his duties with the Institute, Dr. Erlandson was with the Research & Design Branch of the Electronics Div. in the Navy's Bureau of Ships and the Defense Research Laboratory of the University of Texas. It was also announced that *Lubertus Bakker* and *Charles F. Raley* joined the staff of the Institute. Mr. Bakker had been research chemist for the National Oil Products Co. and Mr. Raley a junior research chemist with E. I. du Pont de Nemours & Co., Inc.

(Continued on page 136)

MR. PRODUCT DESIGNER

Industrial resins — and plastics — are finding their way into thousands of unusual, surprising applications.

Perhaps they can solve your design or production problems.

Monsanto will be glad to work with you. Write today!

"We 'cured' our age-old production headaches ...when we banished habit-itis"

says

HAROLD JOHNSON

Works Manager,
Production Foundries Division,
Jackson Industries, Incorporated
Birmingham, Alabama

Monsanto Resinox phenolic resins bind the sand to form inner cores in metal casting. Also used as a binder for the shell formed around the pattern in the "C" process.

Maybe you're not in the foundry business. But have you stopped to consider the unexpected industries in which plastics have recently appeared — and what an amazingly efficient job plastics are accomplishing?

Take Monsanto's Resinox phenolic resins, for instance. Whole new fields of opportunity have been opened up in such applications as bonding wood waste to produce a construction material with all the working qualities of wood; bonding wool, glass fibres and abrasives for grinding and cutting wheels; impregnating brake bands and clutch facings; laminating wood, paper and glass cloth; and now, with the development of the "C" process, an entirely new approach in metal casting that promises to revolutionize this important industry.

Noteworthy among recent developments is the application of Resinox phenolic resins as a core binder.

"We *walloped* the high costs that plagued our business when we discarded age-old casting habits for new ideas in materials and methods—when we switched to a Monsanto Resinox phenolic resin core binder," says Mr. Johnson. "With Resinox we found we could cut our core baking cycles 50 per cent—the equivalent of another core oven — and at the same time produce castings of closer tolerance."

Whatever *your* product, chances are one of Monsanto's broad line of plastics may help you do a better job... turn out a better product. Why not find out what Monsanto Plastics can do for *you*. Just mail the handy coupon. ↓ Resinox: Reg. U. S. Pat. Off.

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Company _____

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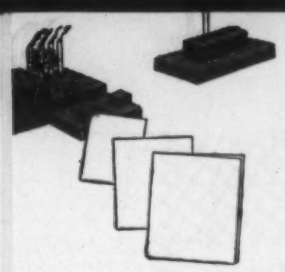

MANUFACTURERS' LITERATURE

Materials

Irons • Steels

Stainless-Clad Copper. American Cladmetals Co., 16 pages, illustrated. Brief description of history, manufacture, properties and applications of Rosslyn Metal, a stainless steel-clad copper. (1)

Tool Steels. Bethlehem Steel Co. Properties, selection data and heat treating information about this company's tool steels. (2)

Alloy Steels. Carpenter Steel Co., 14 pages. Describes properties and fabricating characteristics of two chromium-nickel grades, Carpenter No. 158 and 5-317, which can be used for all applications requiring alloy steels. (3)

Heat Resistant Steels. Chicago Steel Foundry Co. Describes Pyrasteel, a chromium-nickel alloy designed for high resistance to heat, corrosive gases and most concentrated or dilute commercial acids. (4)

Steel Design. Climax Molybdenum Co., 72 pages. Booklet entitled "3 Keys to Satisfaction" tells how to combine good design, high quality steel and proper treatment for best results. (5)

Tool Steel Selector. Crucible Steel Co. of America. Circular, 9-in. dia. selector chooses correct tool steels for desired applications. Indicates type of steel, depth of hardening and machinability, and includes information on heat treating. (6)

Low Alloy Steel. Inland Steel Co. Booklet gives data on Hi-Steel, a strong, abrasion and corrosion resistant structural steel with high notch toughness and fatigue strength. Fabrication is said to be easy, requiring little or no change in shop practice. (7)

Induction Hardened Bar Steel. Jones & Laughlin Steel Corp., 8 pages, illustrated, No. AD-99. Principal advantages of Electreat cold finished steel bars, heat treated by induction coils. Charts show hardenability and mechanical properties. (8)

Clad Steels. Lukens Steel Co., 68 pages, illustrated. Compositions, mechanical properties, corrosion ratings and applications of nickel-clad, stainless-clad, Inconel-clad and Monel-clad steels. (9)

Screw Steel. Joseph T. Ryerson & Son, Inc., 2 pages. Describes Ledloy, a lead-bearing, open-hearth steel that machines from 30 to 50% faster than the fastest cutting screw steel previously available, and has good ductility, strength and case-hardening qualities. (10)

Low Alloy and Stainless Steels. Sharon Steel Corp., 4 pages, illustrated, No. 1a/26. Extensive metallurgical data on this company's line of stainless steels. High-tensile low alloy steels, Cor-Ten and N-A-X, also covered. (11)

Forged Steels. Timken Roller Bearing Co., Steel & Tube Div., 112 pages. Entitled "Evaluating the Forgeability of Steels," this booklet provides detailed forging data of use in design work. (12)

Nonferrous Metals

Aluminum and Its Alloys. Aluminum Co. of America, 154 pages, illustrated, No. AD51. Comprehensive data on properties of aluminum and its alloys, heat treatment of wrought alloys, wrought forms available, alloy castings and their design, and various fabricating practices. (13)

Aluminum Bronze Alloys. Ampco Metal, Inc., "Ampco Metal Catalog." Various grades of Ampco aluminum bronze alloys presented with detailed physical properties. (14)

Magnesium. Brooks & Perkins, Inc., illustrated. Folder gives table of magnesium alloy characteristics, design information, and lists this firm's magnesium products. (15)

Resistant Casting Alloy. Burgess-Parr Co., 4 pages, illustrated, No. 105. Physical properties and applications of Illium "G", a nickel-base corrosion resistant casting alloy. Properties of wrought alloy, Illium "R", also listed. (16)

To obtain literature appearing on these pages, please refer to easy-to-use reply card on page 133.

Magnesium Forms. Dow Chemical Co., Magnesium Div. Technical information on magnesium, its available forms and applications. (17)

Chromium-Nickel Alloys. Electro-Alloys Div., American Brake Shoe Co., 60 pages. Detailed description of cast 16 Chromium-35% nickel alloys, including properties, specifications and applications. (18)

Spring Alloy. Elgin National Watch Co., Industrial Products Div., 2 pages. Composition and properties of cobalt-chromium-base spring alloy, Elgiloy, having high corrosion resistance, set and fatigue resistance, hardness and elasticity. (19)

Aluminum Alloy. Frontier Bronze Corp. Engineering data and metallurgical facts about Frontier 40-E aluminum alloy with high strength, good shock and corrosion resistance, and good machinability. (20)

Corrosion Resistant Alloys. Haynes Stellite Div., Union Carbide & Carbon Corp. Describes Hastelloy alloys—strong, light, easy-to-fabricate alloys with good corrosion resistant properties. (21)

Nickel Alloys. International Nickel Co., Inc. Detailed information on the properties, treatment, fabrication and performance of numerous alloys containing nickel. (22)

Forgeable Bearing Alloys. Mueller Brass Co., 24 pages, illustrated. Detailed discussion of the "600" series copper-zinc alloys especially adapted to hot working. Gives engineering, physical and mechanical properties; applications; machining data; specifications; and other useful information. (23)

Bearing Metal. National Bearing Div., American Brake Shoe Co., 3 pages. Brief description of "Tiger Bronze" bearing material, accompanied by detailed price list of this company's bronze and Babbitt metal. (24)

Zinc and Zinc Alloys. New Jersey Zinc Co., 32 pages, illustrated. Describes physical and engineering properties of rolled zinc and Zilloy, a high-strength zinc alloy with corrosion resistance similar to zinc. Gives specifications, useful buying information and testing methods. (25)

Aluminum Alloys. Reynolds Metals Co., 12 pages, illustrated. Gives fabrication information, types of finish, and applications and properties of this company's aluminum al-

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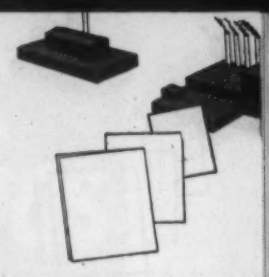


oys. Gives specifications of sheet and plate, ire, rod and bar, tubing and pipe, struc- ural and extruded forms. (26)

Nonferrous Alloys. Riverside Metal Co., 44 ages. Handbook designed to aid in the election of nonferrous alloys. Includes ad- antages, applications, composition, forms, roperties and manufacturing limits of hosphor bronze, nickel silver, cupro nickel nd beryllium copper, as well as special iverside alloys. (27)

Magnesium Alloys. White Metal Rolling & Stamping Corp., Whitelight Magnesium Div., 8 pages. Complete data on Whitelight magnesium alloy rods, bars, shapes, tubes, etc. Includes specifications, physical prop- erties, commercial tolerances, etc. (28)

Nonmetallic Materials • Parts

Plastic Moldings. Accurate Molding Co. De- scribes facilities for producing precision plastic moldings. Case histories given. (29)

Molded Soft Rubber. Acushnet Process Co., 32 pages, illustrated, No. 50. Shows this company's facilities for making a wide va- riety of custom precision molded soft rubber products. Includes data on methods of mold- ing rubber, specifications, case histories on development of compounds for special ap- plications, general properties of various rub- ber compounds, descriptions of natural and synthetic rubbers, etc. (30)

Felt Samples. American Felt Co., 8 pages. S.A.E. felt standards and specifications, with samples exhibiting 16 different grades. (31)

Hard Rubber and Plastics. American Hard Rubber Co., 60 pages. Manual gives de- tailed selection data on hard rubber and plastics materials. (32)

Plastics. Bakelite Div., Union Carbide & Carbon Corp., 32 pages, illustrated, *Bakelite in Review*, Vol. 21, No. 4. Reviews four decades of progress in plastics industry, with emphasis on Bakelite and Vinylite. Six additional articles. (33)

Compounded Elastomers. Chicago Rawhide Manufacturing Co., 32 pages, illustrated. Catalog presents characteristics and proper- ties of Sirvene compounded elastomers. In- cludes applications in the engineering of new products. (34)

Plywood. Douglas Fir Plywood Assn., 32 pages, illustrated. Series of articles show how to use plywood effectively in fixtures, displays, posters and signs. (35)

Plastics. E. I. du Pont de Nemours & Co. (Inc.), 10 pages, illustrated, No. 1B/3. General descriptions and specific advantages and uses of Lucite, Polythene, Nylon, Buta- cite, Pyralin, Plastacele and Teflon. (36)

Plastics News. Durez Plastics & Chemicals, Inc. Monthly *Durez Plastics News* presents many ideas and applications for plastics users. (37)

Cellulose Ester Materials. Eastman Kodak Co., Cellulose Products Sales Div., 8 pages, illustrated, No. H-1-10. Complete data on Kodapak Sheet, a thermoplastic cellulose ester material with important applications in the electrical industry. Specifications for the two types available—Kodapak I, cellu- lose acetate, and Kodapak II, cellulose ace- tate butyrate—are included. (38)

Plastics. General Electric Co., Plastics Div., 16 pages, illustrated, No. 1b/13. Charac- teristics and uses of various grades of molded and laminated plastics. Physical and mechanical properties listed. (39)

Rubber. B. F. Goodrich Chemical Co. De- scribes properties and applications of Hycar rubber, a resilient, abrasion resistant, oil and heat resistant material having high tensile strength and low compression set at elevated temperatures. (40)

Plastic Molding. The Grigoleit Co. Folder describes this company's facilities for pro- ducing molded plastics. Includes designing, engineering, tooling, molding and finishing. (41)

Chlorinated Natural Rubber. Hercules Pow- der Co., 44 pages. Booklet gives mechanical, electrical, thermal and corrosion resistance properties of Parlon, a chlorinated natural rubber. Includes available types and uses along with extensive data on methods of applying the finish base. (42)

Thermosetting Plastic. Houghton Labora- tories, Inc., 4 pages, illustrated. Describes Hysol 6000, said to have unusual chemical and electrical resistance and good machining qualities. Gives uses, specifications, elec- trical properties and resistance to specific chemicals. (43)

Plastic Molding. Mack Molding Co., Inc. Information on this company's services for plastic molding from choice of materials and design, through molding, finishing and delivery. (44)

Promoter for Polyesters. Naugatuck Chemical Div., U. S. Rubber Co. Technical bulletin gives latest findings and applications of this company's latest promoter for liquid poly- esters. (45)

Alkyd Molding Compound. Plaskon Div., Libbey-Owens-Ford Glass Co., 6 pages, il- lustrated, No. 7131. Mechanical, electrical and chemical properties, plus molding char- acteristics of Plaskon Alkyd fast-molding compound. Case history data included. (46)

Rubber Parts. Stalwart Rubber Co. Catalog gives complete line of oil and gas resistant rubber parts of high tensile strength and 40 to 90 durometer hardness. Applications in- clude gaskets, sleeves, washers, tubing, etc. (47)

Molded Ceramics. Star Porcelain Co. Gives technical data on characteristics of molded ceramic products for electrical wiring, elec- trical heating and special purposes. (48)

Inert Plastic. U. S. Gasket Co., Teflon prod- ucts Div., Catalog No. 300. Gives complete specifications and description of available stock of Teflon, a plastic featuring chemical inertness, high dielectric strength and good adhesion resistance. (49)

Carbon Graphite. United States Graphite Co., 40 pages, illustrated. Complete data on Graphitar, a carbon-graphite nonmetallic product that resists chemical attack, has self- lubricating properties and a low-coefficient of friction, is as hard as steel, lighter than magnesium, and will not warp. (50)

Micarta. Westinghouse Electric Corp., 36 pages, illustrated. Applications and advan- tages of Micarta industrial plastic are dis- cussed, with mechanical, electrical and chemical properties given. Includes grade selection tables for both molded and lami- nated Micarta. (51)

Metal Parts • Forms

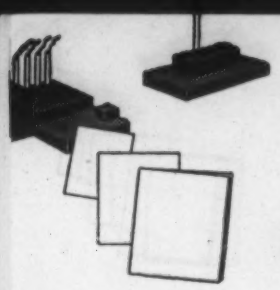
Aluminum Extruded Shapes. Aluminum Co. of America. Booklet explains design po- tentialities of the versatile extrusion process for aluminum. How use of aluminum extruded shapes can save money in fabrica- tion and assembly operations. (52)

Plated Metal Parts. American Nickeloid Co., illustrated. "Flow Chart of Production of Plated Parts" indicates economies in floor space, supervision, personnel, accounting, etc., through elimination of the plating shop by purchase of pre-plated metals for parts manufacture. (53)

Nonferrous Plaster Mold Castings. Atlantic Casting & Engineering Corp., No. 4. De- scribes production of "Atlanticastings" of copper-base and aluminum alloys, poured in plaster molds to tolerances of ± 0.005 in. (54)

Beryllium Copper Springs. Beryllium Corp., 2 pages, illustrated. Data on Berylco 165, a beryllium copper alloy with high strength and good electrical and thermal conduc- tivity. Includes tables of properties and available sizes, design data, and typical ap- plication. (55)

Powdered Metal Parts. Chicago Powdered Metal Products Co., 4 pages, illustrated. Ad- vantages of Camet custom-molded powdered metal parts. Also lists standard materials used and gives tips on designing. (56)



MANUFACTURERS' LITERATURE

Hard Castings. Coast Metals, Inc., 8 pages, No. 949. Discusses and pictures numerous applications of this company's hard castings and hard facing alloys. Advantages obtained by using Coast Metals supported by actual production figures. (57)

Stainless Welding Fittings. Cooper Alloy Foundry Co., 8 pages, No. 52 W. Latest prices of stainless steel welding fittings, including elbows, return bends, stub ends, tees, etc., in Types 304, 316 and 317. (58)

Magnesium Die Castings. Doehler-Jarvis Corp., 4 pages, illustrated. Describes Doler-Mag magnesium die castings, giving physical properties, data on weight savings, typical applications and numerous advantages. (59)

Investment Castings. Engineered Precision Casting Co., 4 pages, illustrated. Describes Epco precision investment castings. (60)

Flexible Tubing. Flexible Tubing Corp., 8 pages, illustrated. Describes features, properties and applications of Spiratube, a flexible tubing available in four designs especially adapted to problems such as fume removal, transferring abrasive materials, etc. (61)

Self Lubricating Bushings. Graphite Metallizing Corp., 8 pages, illustrated, No. 108. Characteristics and uses of Graphalloy self-lubricating bushings. Clearances, materials selection and other design data given. (62)

Weldments. Graver Tank & Manufacturing Co., Inc., 20 pages, illustrated, No. SP106. Shows this company's facilities for design, fabrication and testing of weldments. Points out advantages and numerous uses of welded construction. (63)

Perforated Metals. Hendrick Manufacturing Co., 128 pages, illustrated. Catalog presents complete line of perforated metal products, screens and fabricated metals. Includes a number of useful tables. (64)

Nickel Wire Properties. The International Nickel Co., Inc. Folder contains helpful data on the physical and engineering properties of Monel, nickel and Inconel wire. (65)

Bearing Design. Johnson Bronze Co. Set of data sheets gives detailed information and considerations necessary to good bearing design. (66)

Aluminum Cable. Kaiser Aluminum & Chemical Corp. Detailed information on physical and electrical properties of Kaiser Aluminum ACSR and All-Aluminum Cable. Includes tables of available reel sizes. (67)

Low Alloy Steel Castings. Lebanon Steel Foundry, 4 pages. Reference chart on specification designations, analyses, physical properties and heat treatments for 15 carbon and low alloy steels cast by this company for a wide range of applications. (68)

Aluminum Extruded Shapes. Light Metals Corp., 6 pages, illustrated. Shows a variety of aluminum fabrications and extruded shapes, and facilities to produce these shapes to meet customers' specifications. (69)

Deep-Drawn Shapes. Linde Air Products Co. Complete information on Prest-O-Lite deep-drawn shapes and shells, including applications and design aids. (70)

Die Castings, Etc. Madison-Kipp Corp., 32 pages, illustrated. Describes this company's aluminum and zinc die castings. Also shows Kipp Featherweight air grinder and Fresh Oil lubricators. (71)

Iron Castings. Meehanite Metal Corp., 4 pages, illustrated, No. 32. Detailed tabular summary of physical properties of Meehanite high quality gray iron castings. (72)

Tungsten Carbide Shapes. Metal Carbides Corp., No. 50-G. Shows 1325 different sizes of standard solid tungsten carbide blanks, bars, strips, rods, tubes, bushings, rings, flats, tips, disks and special shapes carried in stock for immediate shipment. (73)

Precision Castings. Microcast Div., Austenal Laboratories, Inc., 16 pages, illustrated. Large variety of applications for Microcast precision castings described. Process advantages and design factors discussed. (74)

Projection Welding Fittings. Ohio Nut & Bolt Co., folder containing eight bulletins and a reprint. Specifications for this company's fasteners and fittings for projection welding. Also detailed description of projection welding process. (75)

Precision Castings. Ohio Precision Castings, Inc., illustrated. Brochure on job study demonstrates production savings through application of Ohio Precision Plaster Mold Castings. (76)

Seamless Aircraft Tubing. Ohio Seamless Tube Co., 70 pages, No. A-2. Specifications, tolerances, physical properties and uses of seamless aircraft tubing of carbon and alloy steels. (77)

Hose, Molded Parts. Resistoflex Corp., 4 pages, illustrated, No. 4g/3. Properties and uses of resinous-lined, reinforced industrial hose and custom-built molded parts produced by this company. (78)

Wire Screens. John A. Roebling's Sons Co. (Woven Wire Fabrics Div.), 12 pages, illustrated, No. W-903. Specifications of Roeflat, Roeslot, Roeton and Double Crimp standard screens, designed for uniform grading and long life. (79)

Stainless Steel Castings. The Stainless Foundry & Engineering Co., 4 pages, illustrated. Shows a variety of stainless steel castings, regulator and valve parts, centrifugal pump impellers, etc., and includes helpful engineering data. (80)

Powder Metal Parts. F. J. Stokes Machine Co., 4 pages, illustrated, *"Stokes News,"* Vol. 3, No. 3. Indicates some of the diverse applications of powder metal parts made in this firm's presses. Also information on company's other processes and products. (81)

Extruded Shapes. Titan Metal Manufacturing Co., 4 pages, illustrated. Chemical composition and physical properties of brasses and bronzes extruded by this company. Typical parts and forms shown. (82)

Seamless Tubing. Tube Reducing Corp., 16 pages, illustrated, No. R2. Describes Rockrite process for manufacturing tubing of numerous metals to closer tolerances and better finishes. Also lists advantages enabling lower costs in machining, and indicates shapes, sizes and forms of tubing available. (83)

Steel Castings. Unitcast Corp., 4 pages, illustrated, No. 1049-S. Folder indicates design advantages of steel castings, such as little machining needed, good appearance and durability. Includes case history. (84)

Metal Forming Facilities. R. D. Werner Co., 4 pages, illustrated. Gives relative merits of cold roll forming and extruding light metal shapes. Shows some of this company's facilities for both types of production. (85)

Coatings • Finishes

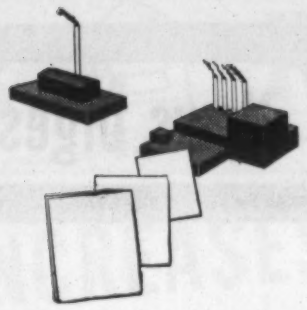
Hardfacing Alloys. Air Reduction Sales Co. Catalog describes complete line of wear-resistant hardfacing alloys said to meet such wear conditions as severe abrasion and medium impact, sliding abrasion and impact, extreme earth abrasion, and corrosion and heat. Alloys applicable by oxyacetylene torch or electric arc. (86)

Metal-Protective Chemicals. American Chemical Paint Co. Folder describes properties and applications of this company's metal-protective and paint-bonding chemicals. (87)

Zinc Bright Dip. Chemical Corp., 4 pages. Leaflet describes "Luster-On," a zinc solution giving a bright finish to pieces dipped into it. (88)

White Enamel. Maas & Waldstein Co. Describes Codur, a gloss white baking enamel. (89)

Corrosion Prevention. Metallizing Engineering Co., Inc., 4 pages, illustrated, No. 93. Describes Metco systems for metallizing steel with zinc or aluminum to prevent corrosion. Gives advantages, typical uses and recommended systems for use in specific atmospheres. (90)



MANUFACTURERS' LITERATURE

nd triangular shapes. Also, bit holders with echanical clamping and adjustment. (137)

ies, Jigs and Fixtures. Connecticut Tele-hone & Electric Div. of Great American dustries, Inc., 20 pages, illustrated, No. 500. Describes this company's facilities for aking dies, jigs, fixtures, and the special uipment needed in the manufacture of a ide variety of products. (138)

trusion Presses. Lake Erie Engineering orp., 8 pages, illustrated, No. 14. Presents is company's horizontal and vertical esses for extruding lead, nonferrous met-s, carbon and lead casing for hose and ble. (139)

djustable Dies. S. B. Whistler & Sons, Inc. atalog describes complete line of this firm's djustable perforating dies of various sizes d shapes. Lists such advantages as inter-hangeability of parts and time-saving set-ps. (140)

old Roll Forming. The Yoder Co., 86 pages, lustrated. Detailed discussion of roll form-g, covering its function, scope and eco-omics; materials and sizes used; advantages ch as uniformity, accuracy, high strength-eight ratio; possible cold rolled forms; d this company's products for cold rolling. (141)

Inspection • Testing • Control

Thermocouples. Charles Englehard, Inc. Complete information on thermocouples nd accessories said to meet all requirements temperature measurement. (142)

Thickness Gages. General Electric Co., Ap-paratus Dept., No. GEC-319. Describes Type A and B thickness gages for measuring etal coatings, glass, plastics, paper, mica, rass and other nonmagnetic materials. (143)

urface Pyrometer. Illinois Testing Labora-ories, Inc., No. 4257. Describes Alnor yrocon, a pyrometer which gives quick, ccurate temperature readings of all surfaces, etallic or nonmetallic, flat or curved, sta-ionary or moving. (144)

atigue-Testing Machines. Krouse Testing achine Co., 10 pages, illustrated, No. 6-B. Detailed descriptions of this com-any's plate and sheet fatigue testing ma-hines including specifications, attachments nd directions for preparation of specimens nd stress calculation. (145)

Universal Testing Machine. Tinius Olsen esting Machine Co. Complete information on the new Olsen hydraulic Super "L" Universal Testing Machine for tension and compression testing. Ranges of 0 to 60,000 lb., 0 to 12,000 lb., 0 to 1200 lb. and additional lower ranges available. Ranges up to 400,000 lb. also available. (146)

Thickness Measurement. Sperry Products, Inc., 4 pages, illustrated, No. 3700. Describes the Reflectogage, a portable ultrasonic instrument providing accurate, visual indications of thickness of metals and other materials from one side of the material only. Specifications included. (147)

Temperature Controls. Wheelco Instruments Co., 4 pages, illustrated, *Wheelco Comments,* Vol. 9, No. 3. Information on the use of this company's temperature control instruments to increase the capacity of wire patenting process and lower costs. (148)

Hardness Tester. Wilson Mechanical Instrument Co., Inc. Information on Tukon Testers for micro-indentation hardness testing. Three models cover full range from micro to macro hardness testing using loads from one gram to 50,000 grams. (149)

General

Lifters. Cullen-Friestedt Co., Bulletin No. SL-25. Gives complete details on all types of C-F Lifters for lifting and transporting heavy materials. (150)

High Vacuum Pumps. Distillation Products Industries. Information on high vacuum pumps of unique, economical design for such uses as metal processing and dehydration. (151)

Corrosion Resistance Computer. H. M. Harper Co. A two piece, pocket-sized, sliding-indicator-type computer gives an easy method of determining what metal alloy can be used with any of nearly 150 corrosive agents. (152)

Wire Straightening and Cutting Machines. Mettler Machine Tool, Inc., 4 pages, illustrated. Gives operating instructions and advantages of five types of Shuster wire straightening and cutting machines. (153)

Vacuum Cleaner. The Spencer Turbine Co., 20 pages, illustrated, No. 144. Describes wide range of applications of the Spencer Vacuum, which removes, lifts, sorts and conveys metals, lint, liquids or gases. (154)

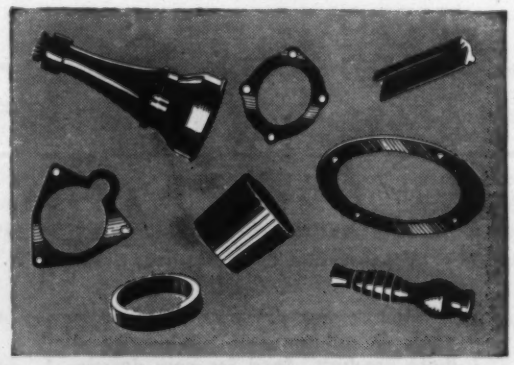
Oil and Gas Resistant Rubber Parts

NEW COMPOUNDS ASSURE LONG LIFE AND MINIMUM SWELL

Rubber parts featuring LONG LIFE and MINIMUM SWELL now can be fabricated from new compounds which will withstand the chemical action of petroleum products and their derivatives as well as industrial and commercial lubricants. Oil and gasoline-resistant rubber parts can be supplied to fit many applications in the automotive, chemical processing, aviation, electrical, and industrial equipment manufacturing industries.

Parts made from the new compounds can have tensile strength from 500 to 2500 psi, durometer hardness from 40 to 90, and elongation from 100 to 600%. Oxident additives will provide weatherproof qualities.

Gaskets, sleeves, washers, tubing, and molded parts and extruded cross-sections can be furnished to meet either S.A.E. requirements or specific applicational needs.



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"Granodine" forms a zinc-iron phosphate-coating bond on sheet metal products — automobile bodies and fenders, refrigerator cabinets, etc. — for a durable, lustrous finish.

"Lithoform" makes paint stick to galvanized iron and other zinc and cadmium surfaces.

"Alodine", the new ACP protective coating chemical for aluminum, anchors the paint finish and protects the metal.

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"Permadine", a zinc phosphate coating chemical, forms on steel an oil-adsorptive coating which bonds rust-inhibiting oils such as "Granoleum."

"Thermoil-Granodine", a manganese-iron phosphate coating chemical, forms on steel a dense crystalline coating which, when oiled or painted, inhibits corrosion.

PROTECTION FOR FRICTION SURFACES

The oiled ***"Thermoil-Granodine"*** coating on pistons, piston rings, cranks, camshafts and other rubbing parts, allows safe break-in operation, eliminates metal-to-metal contact, maintains lubrication and reduces the danger of scuffing, scoring, galling, welding and tearing.

IMPROVED DRAWING AND EXTRUSION

"Granodraw" forms on pickled surfaces a tightly-bound adherent, zinc-iron phosphate coating which facilitates the cold mechanical deformation of steel, improves drawing, and lengthens die life.

Write or call for more information on these products. Send for new descriptive folder on ACP Metal-Protective and Paint-Bonding Chemicals.

American Chemical Paint Co.
AMBLER ACP PENNA.

News Digest

The American Steel & Wire Co. has promoted *Perry T. Coons* to the position of assistant to the vice president—sales of this U. S. Steel Co. subsidiary. At the same time, the Wire Rope & Construction Materials Div. of the company, headed for 14 years by Mr. Coons, has been split into two separate sales units. *M. E. Capouch* was named manager of the Construction Materials Sales Div., while *E. T. Eggers* became manager of the Wire Rope Sales Div. Both men previously had been assistant managers of the former Division. Another appointment by the Company was that of Dr. *Arthur M. Edwards* to the newly-created post of medical director.

Fleet Admiral *William F. Halsey, Jr.* (U.S.N. retired) has been elected chairman of the board of directors of All America Cables & Radio, Inc.

The Hood Rubber Co., a division of the B. F. Goodrich Co., appointed *Harold B. Leland* vice president-manufacturing of the company.

A series of promotions affecting development personnel in several plants of The Goodyear Tire & Rubber Co. have been announced. *Philip W. Drew* was recalled to Akron for a new and important assignment. *C. R. Washburn* succeeds Mr. Drew as technical superintendent at the Los Angeles plant. Assuming Mr. Washburn's position as technical superintendent at Topeka, Kan., is *L. H. Bennett. L. D. Treleaven,* a development compounder, will take over Mr. Bennett's duties as chief chemist at Topeka. And *Robert W. Maney,* in charge of tire production at Plant 2, was named plant manager of the Los Angeles plant. He succeeds *Frank A. Steele,* who will retire Sept. 1 after 40 years of continuous service with the company.

Two executives of the Federal Telephone & Radio Corp. have been elected vice presidents — *William Hatton* and *Frank B. Powers.* Mr. Hatton previously served as director of manufacturing and engineering for International Telephone & Telegraph Corp. and affiliated companies, while Mr. Powers joined Federal last year as director of manufacturing operations.

C. W. Craig and *C. E. Ericson* have been appointed manager and comptroller, respectively, of the North Chicago branch of the Atlas Powder Co.'s Industrial Finishes Dept. Mr. Craig formerly was assistant manager at North Chicago, while Mr. Ericson was office and credit manager. At the same time, *Casper Apeland,* branch manager, was named special representative for market research for both the North Chicago and Stamford, Conn., plants.

The Baker-Raulang Co. has elected *H. Dudley Swim* chairman of the board, *Clarence M. Taylor* chairman of the executive committee, and *John R. Morrill* vice

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SPIRATUBE
FLEXIBLE TUBING
Diameters to 30 inches

SPIRATUBE . . . the amazing new flexible tubing . . . works efficiently both ways . . . blowing . . . exhausting.

A zephyr or a gale . . . you put air where you need it with SPIRATUBE. And SPIRATUBE-R's neoprene rubber cushion rides with the punch of abrasive solids. It's the new conveying tube of industry. Ideal for dust and fume collection and thousands of other applications.

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POLYESTER REPORTER

NEW PROMOTER INCREASES HANDLING EASE OF LIQUID POLYESTERS IN VERTICAL LAY-UPS

The handling advantages of liquid polyesters can now be more easily utilized in such vertical lay-ups as boat hulls, rectangular box constructions, and others without drainage problems. This new technique requires no pre-warming and cooling step as with the waxy type resins nor close tolerances on the lay-up time as with trigger-promoted systems. It is based on the discovery of a promoter whose action gives quick gelation but does not trigger the catalyst, so that plying up and curing of one or more layers may be delayed for eight hours or more. A typical formulation and procedure is as follows:

❶ FORMULA:

VIBRIN 112	100 parts
Benzoyl peroxide	1.5 parts
Styrene	0.8 parts
Promoter #4	2.2 parts

❷ MIXING PROCEDURE:

Weigh out the benzoyl peroxide and add the styrene to it (a dropper may be used for convenience on small amounts of liquids but should be calibrated first). Allow to stand for five minutes, then weigh in the VIBRIN and stir to clarity. Avoid stirring in air. Add the Promoter #4 and mix thoroughly for one minute; again avoid whipping in air.

❸ MAT HANDLING PROCEDURE:

Place a layer of cellophane on flat working area and then place mat or fabric on this. Now pour the mixture prepared in "2" uniformly over the mat, cover with cellophane and roll or squeeze lightly to distribute resin uniformly. Gelation will now occur in several minutes, depending on the working temperature of the materials used (all of which should be kept at same temperature for most uniform results). As a guide, the following temperatures should hold approximately:

100° F.	initial gelation in	4	minutes	
90° F.	"	"	6	"
80° F.	"	"	7	"
70° F.	"	"	9	"

No temperatures below 70° F. are recommended, as firm gelation is not always obtained.

❹ BUILDING PROCEDURE:

When the mat has gelled as in "3" it can be used immediately but it is preferable to wait another fifteen minutes, when it will be somewhat firmer, and will then remain in a usable condition at normal temperatures for at least eight hours. Some pressure (30 psi or more) is necessary to get good contact between plies in a laminar construction and heat is applied in the usual manner to initiate and obtain a final cure.

NEW METHODS—NEW MATERIALS AVAILABLE TO YOU

The promoter described above is typical of the improved methods and materials which we are constantly developing in our laboratories. Many are produced in solving specific problems our users give us . . . saving time and cost, creating new ingredients for specialized needs. In addition, 7 standard VIBRIN types are now available, among them self-extinguishing and water white. *Remember, there's always a Naugatuck technician ready to solve your problems.*

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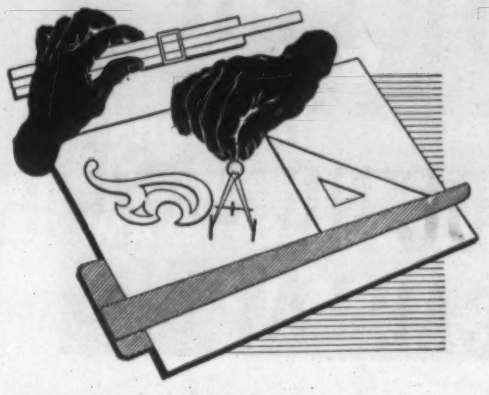

Design + Metallurgy = SATISFACTION

For specifying a steel machinery part, the designer and the metallurgist make a fine team.

If the part is properly designed (and this means taking the metallurgical treatment into account) the choice of a steel and its proper treatment become relatively simple.

So important are these aspects of good and poor design of parts in relation to the choice of steel and its treatment—the work of the designer and the metallurgist—that we have compiled a 70-page book on this subject, giving many sketches as examples. "THREE KEYS TO SATISFACTION" is interesting and helpful to designers and metallurgists; it is free on request.

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MOLY

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News Digest

president in charge of sales. Mr. Swim had been a member of the board of directors and Mr. Taylor executive vice president of Baker, while Mr. Morrill previously served as assistant to the vice president in charge of public relations, sales promotion, dealer relations and advertising for the Lincoln Electric Co.

Louis R. Botsai has been appointed manager of the Motor & Control Div. of Westinghouse Electric Corp. Mr. Botsai, formerly manager of the Company's Gearing Div., succeeds *Leon R. Ludwig,* who has been assigned to the staff of John K. Hodnette, vice president of Westinghouse.

United States Rubber Co. has promoted *Elmer H. White* to the position of advisor to the president, the executive committee and the general managers on sales, sales promotion, advertising and distribution. *Walter H. Norton* succeeds Mr. White as vice president and general manager of the Footwear & General Products Div. of the Company. And *Chester J. Noonan,* general sales manager, assumes Mr. Norton's position as assistant general manager of the Division.

William E. Ireland, vice president-sales of International B. F. Goodrich Co., has been named vice president-general manager of the Tire Sales Div. of B. F. Goodrich Co. of Canada, Ltd.

The death of *George W. Pressell,* vice president of E. F. Houghton & Co., occurred suddenly at his summer home. Mr. Pressell was the oldest Houghton employee in point of service, having started as a messenger boy 47 years ago.

News of Companies

The *Burgess-Parr Co.,* Freeport, Ill., has changed its company name to *The Illium Corp.,* due to the close association of the Company with its principal product, Illium—an extremely corrosion resistant alloy.

Manufacturing operations are still being continued at the *A. F. Holden Co.'s* New Haven, Conn., plant, but the executive offices, as well as manufacturing operations, are now located at the new plant—11300 Schaefer Highway, Detroit 27.

The *Chemical Dept.* of the *General Electric Co.,* Pittsfield, Mass., has discontinued the fabrication of laminated plastics at the Coshocton, Ohio, plant of its Laminated & Insulating Products Div. This operation, which produced fabricated parts for industry from G.E. Textolite laminates, has been sold to *General Laminated Products, Inc.,* who has plants in New York and Chicago. G.E. will continue to produce Textolite laminates in the form of sheets, tubes and rods at Coshocton.

Commencement of operations at a new plant in Calumet City, Ill., has been announced by *Catalin Corp.,* New York City. The company has also acquired land and installed large capacity, low-temperature storage tank facilities at Thomasville, N. C.

Tennessee Eastman Corp., Kingsport, Tenn., has instituted delivery of plasticizers and solvents by tank wagon from its plant in Kingsport. It is expected that this method of delivery will soon be extended to several Eastman chemicals other than plasticizers and solvents.

Acquisition of a lot adjoining the premises of the *Wheelco Instruments Co.* at W. Harrison St., Chicago, has been announced by Wheelco. The new property will be used as a warehouse.

Eutectic Welding Alloys Corp., New York 13, announces sponsorship of a $1,000 prize competition for technical papers having to do with research and development in the field of non-fusion welding processes. The contest begins Sept. 1, 1950 and closes May 31, 1951. The competition is open to welding engineers, researchers, metallurgists, instructors, university students and all others qualified to present basic principles of the art and science of non-fusion welding. Detailed information may be secured by writing directly to Eutectic at 40 Worth St., New York 13.

One of the most powerful atom smashers of its type in the world—a 100,000,000-volt betatron built by the *General Electric Co.,* Schenectady, N. Y.—is now installed and undergoing tests at the University of Chicago's Institute for Nuclear Studies.

The *Watertown Manufacturing Co.,* Watertown, Conn., has acquired the physical assets of the *Moulded Metals Co., Inc.,* also of Watertown.

Winners of the Cooper Alloy contest relating to "Applications for Cast Stainless Steel in the Chemical Industry"—sponsored by the *Cooper Alloy Foundry Co.,* Hillside, N. J.—have been announced. First prize winner was Howard J. Sanders, chemical engineer with the Calco Chemical Div. of American Cyanamid Co. Second prize went to John D. Altstetter, a metallurgical engineering student at Ohio State University. And Max J. Sorensen, a student at Villanova College, received the third prize. Judges of the contest were T. C. Du Mond, editor of MATERIALS & METHODS; E. C. Fetter, managing editor of *Chemical Engineering;* and D. W. Talbott, vice president and general manager of Cooper Alloy Foundry.

Ampco Metal, Inc., Milwaukee, Wis., has appointed *Jaeger Welding Supply, Inc.,* Springfield, Mass., and *Texas Welding Supply Co.,* Dallas, Tex., as franchised distributors in their respective areas.

UNITED CARR FASTENER CUTS PLATING REJECTS AND PRODUCTION TIME

with the Du Pont

SODIUM HYDRIDE DESCALING PROCESS

Courtesy: United Carr Fastener

Loading perforated dip basket with closure buttons for immersion in sodium hydride descaling bath.

Since 1946, United Carr Fastener Corporation has used the Du Pont Sodium Hydride Descaling Bath in its Cambridge, Mass., plant for the thorough cleaning of intricately shaped steel objects prior to finishing. This efficient process which preserves base metal surfaces has enabled United Carr to maintain high dimensional accuracy on its fastener products. And plating rejects due to blistering have been eliminated!

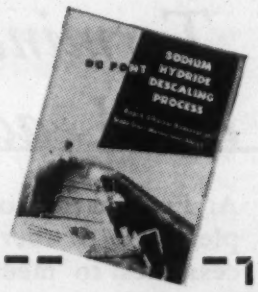
Operator removing sodium brick to charge generator. Closure buttons in basket are ready for descaling.

Production time has been sharply cut, too. The bath has proved so efficient in removing scale from recesses and indentations not reached by other cleaning methods that parts are now cleaned in one-fourth the time formerly required. A net saving of 75% in acid cost has been realized along with a substantial reduction in spent acid disposal. In addition, subsequent polishing and burnishing operations have been reduced 50 to 75%.

Tempering of the work is now done simultaneously with descaling. The descaling equipment handles over 600 lbs. of work hourly. Accessory equipment includes a cyanide neutralizing tank to treat work which is not to be finished immediately.

United Carr Fastener's complete satisfaction with the Du Pont Sodium Hydride Descaling Process can be duplicated over and over again by many other plants. Why not investigate its possibilities for your own operations? Send the coupon below for your copy of the booklet "Du Pont Sodium Hydride Descaling Process." It describes the process and tells how it can mean important savings in metal, time, space, and materials in your plant.

Closure buttons are released into quench tank through hinged bottom of basket.



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News Digest

News of Societies

Establishment of an *Electronic Core Div.* for iron powder electronic core manufacturers has been announced by the *Metal Powder Assn.* At a recent meeting William E. Cairnes, president of Radio Cores, Inc., was elected chairman.

Grant S. Wilcox has been elected president of the *Engineering Society of Detroit.* Mr. Grant is assistant factory manager of the Plymouth Div. of the Chrysler Corp., and previously served as chairman of the Detroit Chapter of the American Society of Tool Engineers and national director of that Society.

J. Calvin Brown, engineer and patent attorney, was nominated as the 1951 president of the *American Society of Mechanical Engineers.* Formal election will take place in the Fall by letter ballot of the membership.

Appointment of Dr. Egon Orowan as a full professor on the staff of the Mechanical Engineering Dept. at *Massachusetts Institute of Technology,* was announced. Dr. Orowan is one of the outstanding authorities in the general field of physics of metals.

Dr. Gerald A. Rosselot, director of the Engineering Experiment Station at the Georgia Institute of Technology, was recently elected chairman of the *Engineering College Research Council.* In addition to this post, Dr. Rosselot will also serve as a vice president of the *American Society for Engineering Education.* Another Research Council officer named to serve as vice chairman during 1950-51 was Professor A. G. Conrad, head of the Dept. of Electrical Engineering, Yale University.

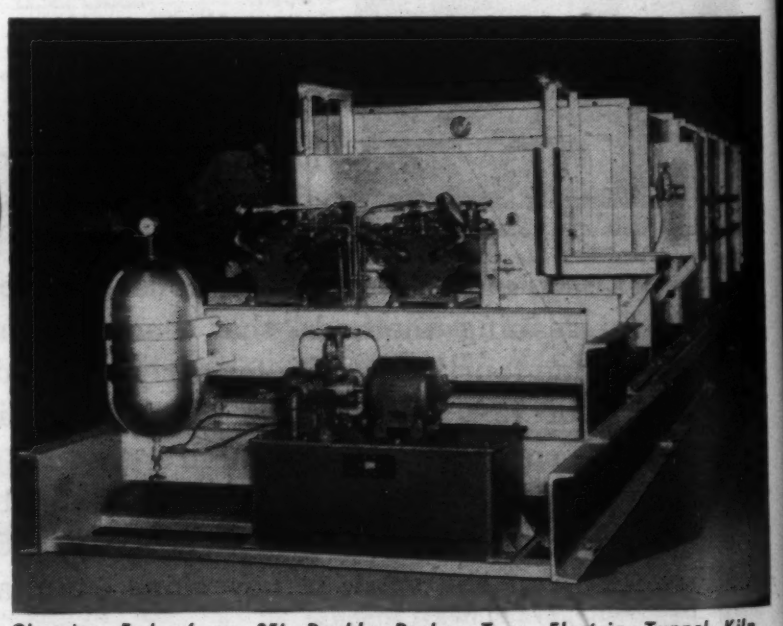
Frank Crossley, former part-time instructor at the *Illinois Institute of Technology,* has received the first doctor of philosophy degree in metallurgical engineering ever awarded by the Institute. This September he will establish and direct a department of metallurgical engineering at the Tennessee Agricultural and Industrial State college.

The *Wire Association* has awarded an honorable mention for 1949 to E. G. deCoriolis and Orville E. Cullen, for their paper, presented at the 1949 annual convention of the Association. They both are connected with Surface Combustion Corp., Mr. deCoriolis as director of research and Mr. Cullen as chief metallurgist.

Harper

Fast

Cycle Firing



Charging End of an 85' Double Pusher Type Electric Tunnel Kiln

electric tunnel kilns

Harper Fast Cycle Electric Tunnel Kilns are adept for firing special high temperature Ceramics such as titanates, zirconites, ferrites, steatites and electrical porcelain, insulators, resistors, spark plugs, and grinding wheels on schedules which insure faster delivery and continuous high quality production of ware at low first cost of equipment.

Tunnel kilns are available in either single or double capacity, slab-pusher type or car type.

Write, telling us your tunnel kiln requirements and we will be glad to recommend suitable equipment as well as review our experience in the firing of the various Ceramic products with you.

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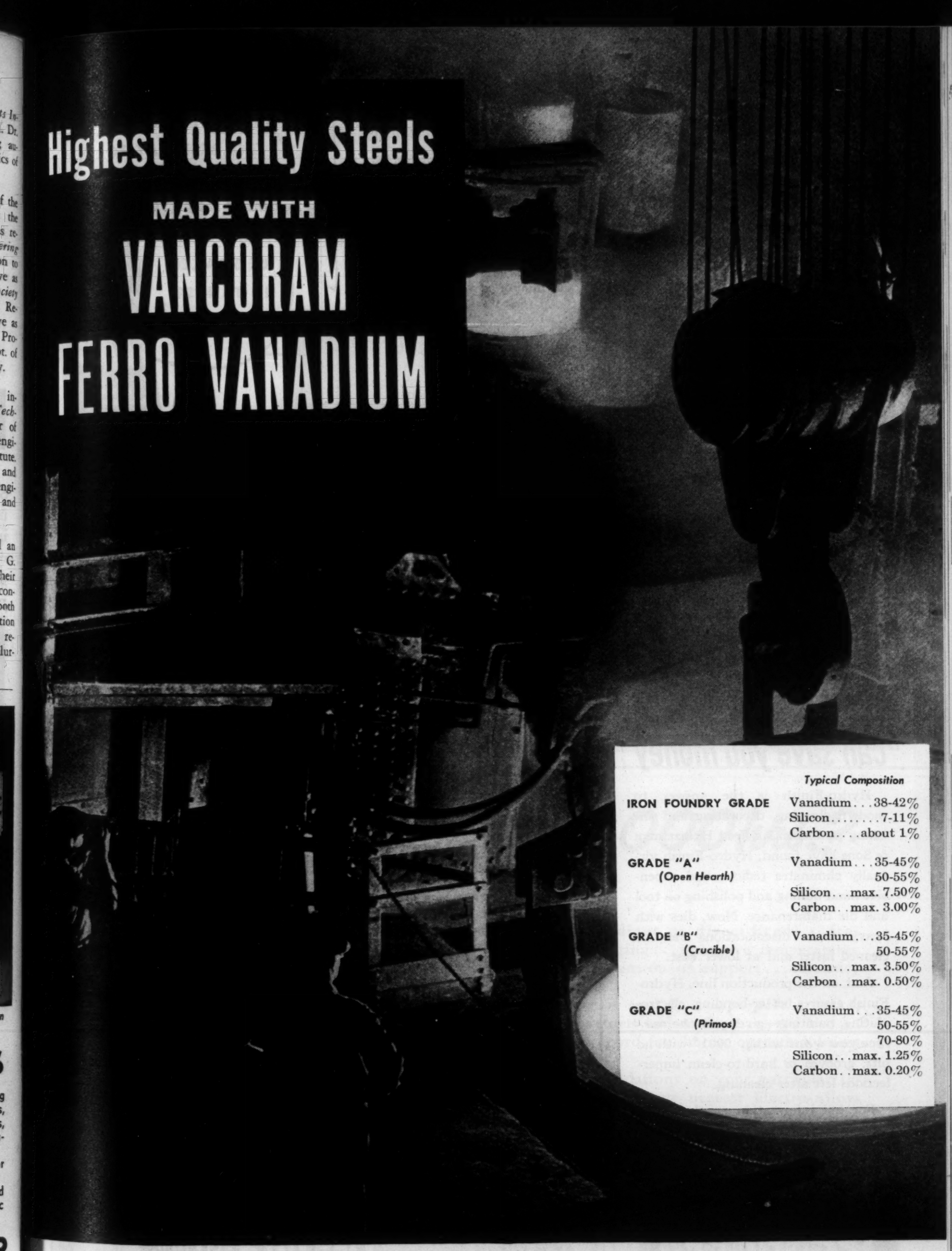

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IRON FOUNDRY GRADE	Vanadium . . . 38-42% Silicon . . . . . 7-11% Carbon . . . . about 1%
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GRADE "B" *(Crucible)*	Vanadium . . . 35-45% 50-55% Silicon . . . max. 3.50% Carbon . . max. 0.50%
GRADE "C" *(Primos)*	Vanadium . . . 35-45% 50-55% 70-80% Silicon . . . max. 1.25% Carbon . . max. 0.20%

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reports Mr. J. L. Crosby, General Manager

***Shown here** is the Pangborn Hydro-Finish unit which set new records at Fred Heinzelman & Sons. A pioneer of heat treated dies, the company reports: Hydro-Finish removes heat treat oxide discoloration, cuts hand polishing 60% to 70%, holds tolerances to a precision .0001"!*

Find out how HYDRO-FINISH *can save you money*

Hydro-Finish is the answer to modern cleaning, decorating and finishing problems. As Fred Heinzelman & Sons have found, Hydro-Finish virtually eliminates tedious and expensive hand buffing and polishing on tool and die maintenance. Now, dies with heavy oxide discolorations can be cleaned faster and at lower cost.

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Meetings and Expositions

ILLUMINATING ENGINEERING SOCIETY, national technical conference. Pasadena, Calif. Aug. 21-25, 1950.

AMERICAN INSTITUTE OF ELECTRICAL ENGINEERS, Pacific general meeting. San Francisco, Calif. Aug. 23-26, 1950.

AMERICAN MINING CONGRESS, metal mining convention and exposition. Salt Lake City, Utah. Aug. 28-31, 1950.

AMERICAN CHEMICAL SOCIETY, national meeting. Chicago, Ill. Sept. 3-8, 1950.

NATIONAL CHEMICAL EXPOSITION. Chicago, Ill. Sept. 5-9, 1950.

SOCIETY OF AUTOMOTIVE ENGINEERS, tractor meeting. Milwaukee, Wis. Sept. 12-14, 1950.

NATIONAL PETROLEUM ASSOCIATION, annual meeting. Atlantic City, N. J. Sept. 13-15, 1950.

PORCELAIN ENAMEL INSTITUTE, annual forum. Urbana, Ill. Sept. 13-15, 1950.

AMERICAN SOCIETY OF MECHANICAL ENGINEERS, Instruments and Regulators Div. conference. Buffalo, N. Y. Sept. 18-22, 1950.

INSTRUMENT SOCIETY OF AMERICA, national instrument exhibit. Buffalo, N. Y. Sept. 18-22, 1950.

AMERICAN SOCIETY OF MECHANICAL ENGINEERS, fall meeting. Worcester, Mass. Sept. 19-21, 1950.

ILLUMINATING ENGINEERING SOCIETY, national meeting. French Lick, Ind. Sept. 19-23, 1950.

PACKAGING MACHINERY MANUFACTURERS INSTITUTE, annual meeting. Hot Springs, Va. Sept. 23-26, 1950.

STEEL FOUNDERS' SOCIETY, annual fall meeting. Hot Springs, Va. Sept. 25-26, 1950.

PETROLEUM MECHANICAL ENGINEERING CONFERENCE. New Orleans, La. Sept. 25-28, 1950.

ASSOCIATION OF IRON & STEEL ENGINEERS, annual convention. Cleveland Ohio. Sept. 26-29, 1950.

INDUSTRIAL PACKAGING & MATERIALS HANDLING EXPOSITION. Philadelphia, Pa. Sept. 26-29, 1950.

SOCIETY OF AUTOMOTIVE ENGINEERS, aeronautic and aircraft engineering display. Los Angeles, Calif. Sept. 27-30, 1950.

AMERICAN GAS ASSOCIATION, annual convention. Atlantic City, N. J. Oct. 2-6, 1950.

AMERICAN SOCIETY FOR METALS, annual meeting. Chicago, Ill. Oct. 23-27, 1950.

AMERICAN WELDING SOCIETY, annual meeting. Chicago, Ill. Oct. 23-27, 1950.

NATIONAL METAL CONGRESS. Chicago, Ill. Oct. 23-27, 1950.

WHAT'S THE BEST WAY TO STRIP PAINT FROM METAL PARTS TOO LARGE TO BE SOAKED IN TANKS?

See Page 3

Oakite's New FREE Booklet on Paint Stripping

answers many questions that will lead you to better stripping procedures. You'll want to read more about:

What's the best way to strip large areas of structural metal where a steam supply is available? *See page 5.*

What is the best method when steam is not available? *See page 7.*

What is the cheapest way to strip metal parts in large volume? *See page 9.*

What are the best ways to prepare stripped surfaces for repainting? *See page 11.*

What strippers are best for removing oil-base paints? . . . Synthetic enamels, alkali-resistant plastics or resin-based paints? . . . Japans, wrinkle finishes, nitrocellulose lacquers, alkyds, phenolics and ureas? ***See page 12.***

FREE For a copy of "How to STRIP PAINT" write to Oakite Products, Inc., 32H Thames St., New York 6, N. Y.

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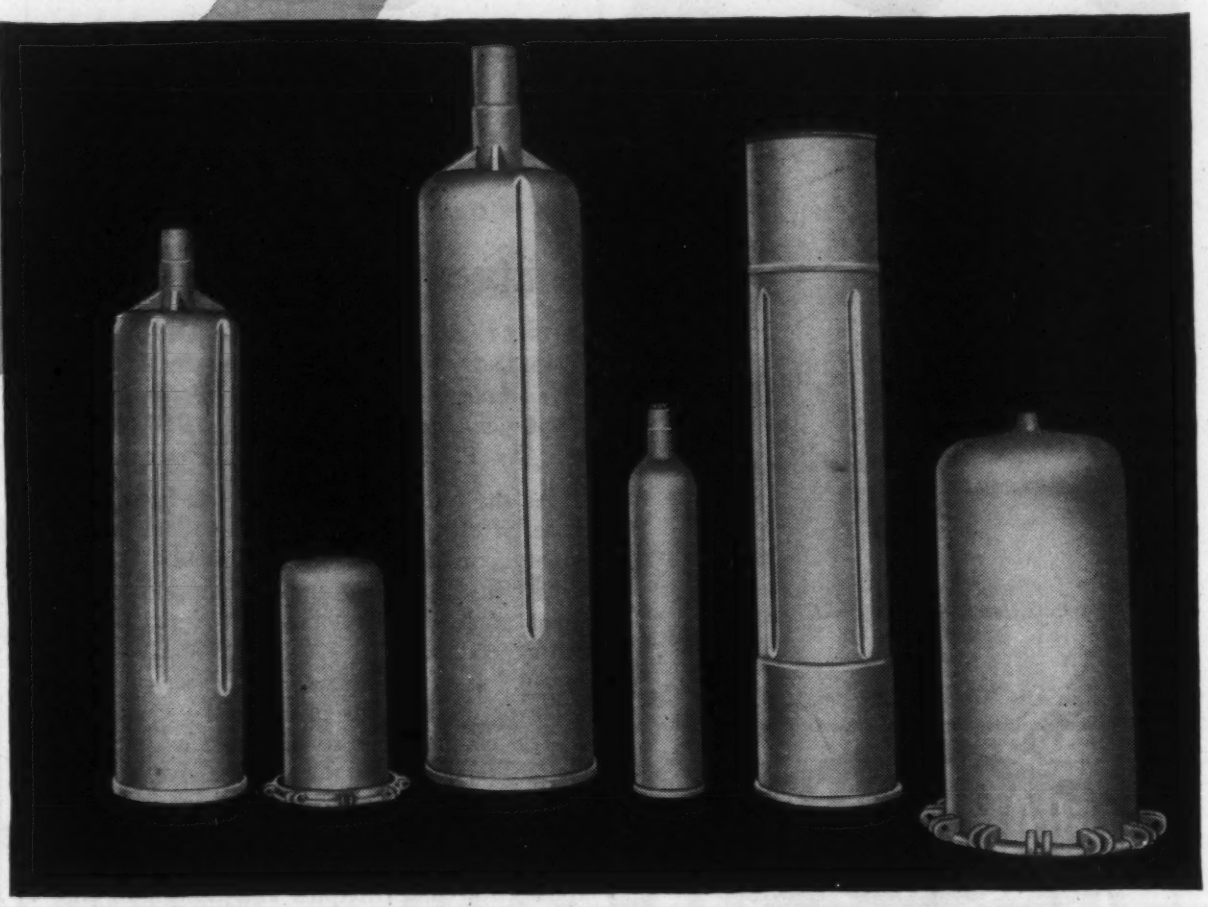

3600 hrs.?... 80,000 hrs.?

Let's be honest. We could claim that our retorts last 80,000 hours. Some have. We could claim they last 10,000 or 12,000 hours. Many have.

We have also had some go out of service after 3600 hours. But even so, Thermalloy* had outlasted—for that particular service—most previously used retorts.

The point is, there are too many variables in methods of operation and maintenance for us or any other manufacturer to make general claims on retort life. These factors include: cycle of heating (batch or continuous) . . . method of heating (radiant or direct-fired) . . . frequency of charging . . . operative temperatures . . . type of suspension or support . . . efficiency of maintenance.

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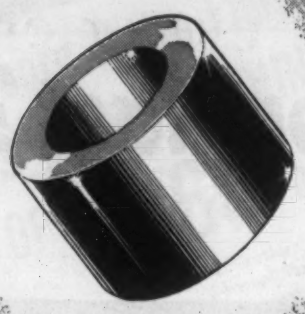

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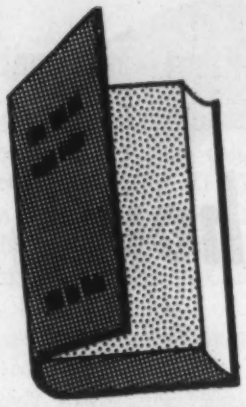

BOOK REVIEWS

Resistance Welding

RESISTANCE WELDING — DESIGNING, TOOLING AND APPLICATIONS. *By Wallace A. Stanley. Published by McGraw-Hill Book Co., Inc., New York 18, 1950. Cloth, 8¾ by 11¼ in., 329 pages. Price $7.50.*

As the author points out, the basic purpose of this book is "to assist designing, manufacturing, tooling and welding engineers in the development of their own ideas of how metal-made products can be more economically and efficiently produced." It is not intended as a set of fixed rules or methods of procedure.

The chapters are so arranged as to carry the reader through three successive stages: background, or basic information on resistance welding; application of that background in designing the product; and application of principles and design in the tooling and manufacture of the product.

The material presented reflects the experience of hundreds of leading welding shops, and emphasizes modern developments and trends. Almost 800 photographs and line drawings are used to picture tools, methods and procedures which have resulted in fabricating economies. Specific processes covered include spot, projection, seam and flash butt welding.

Other New Books

EQUILIBRIUM DATA FOR TIN ALLOYS. *Published by the Tin Research Institute, Greenford, England, 1949. Paper, 7 by 9¾ in., 60 pages. Price 50c, available in the United States from Tin Research Institute, Inc., 492 W. Sixth Ave., Columbus 1, Ohio.* Existing data on the thermal equilibria of the more important tin-containing binary metallic systems are summarized in diagram form.

AN INDEX OF NOMOGRAMS. *Compiled and edited by Douglas Payne Adams. Published by The Technology Press, Massachusetts Institute of Technology, and John Wiley & Sons, Inc., New York 16, N. Y., 1950. Cloth, 7½ by 9¾ in., 174 pages. Price $4.00.* A valuable guide to over 1700 time-saving and error-reducing nomograms published in 21 fields of science and engineering.

STRESS AND STRENGTH OF MANUFACTURED PARTS. *By C. Lipson, G. C. Noll and L. S. Clock. Published by the McGraw-Hill Book Co., New York 18, N. Y., 1950. Cloth, 6¼ by 9¼ in., 259 pages. Price $4.50.* This book is written specifically for designers, engineers and metallurgists who are called upon daily to cope with problems of stress and strength and the prevention of failures of parts and assemblies.

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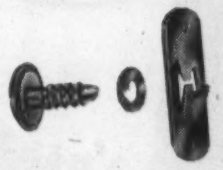

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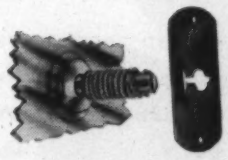

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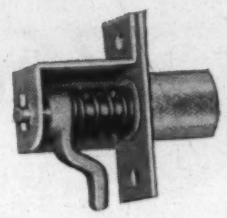

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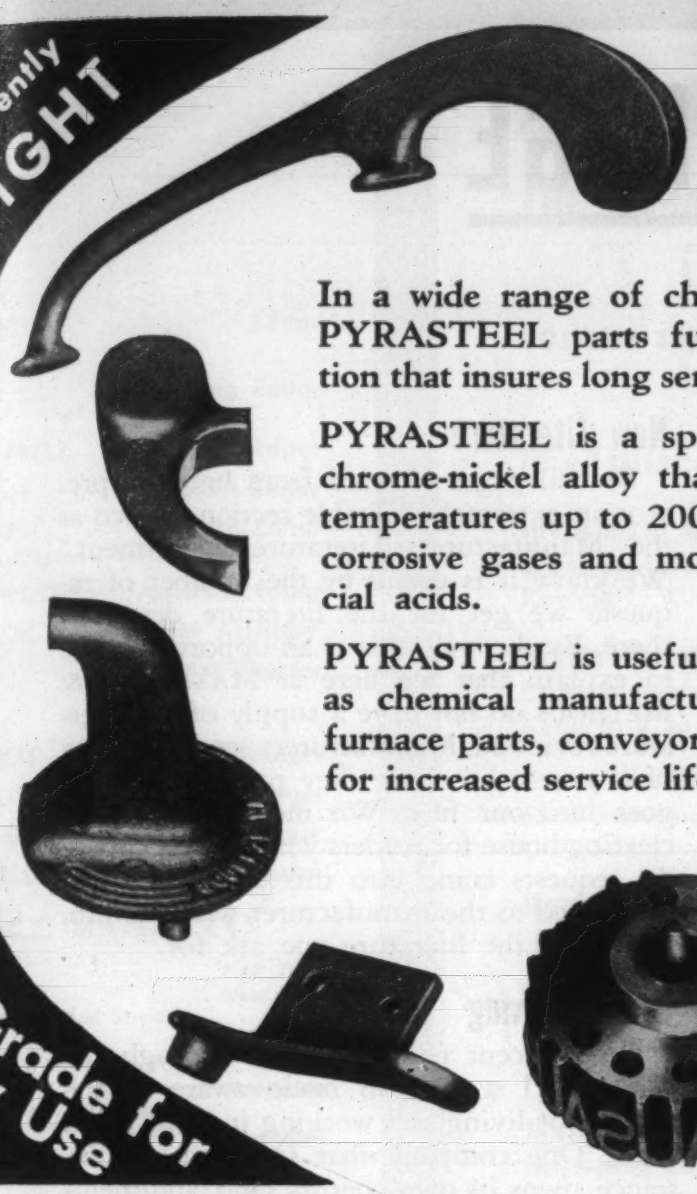

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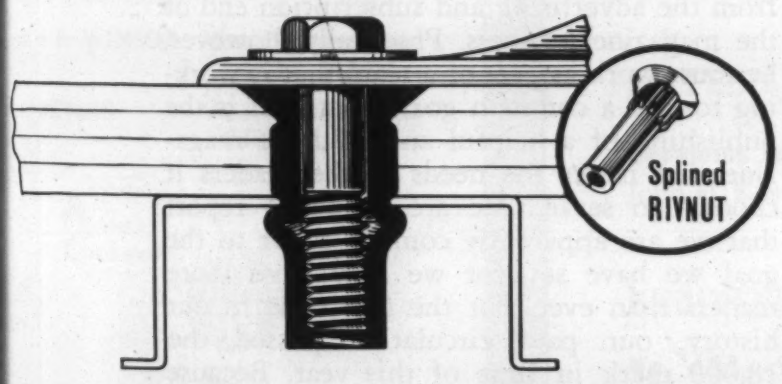

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THE EDITOR'S PAGE

It's a Small World, Etc.

Every once in a while the trite saying about the size of the world is made true. We have a good example of that here in the M&M Editorial Department. It's not such a long story.

In June we hired a young engineering graduate to work part time as an editor and devote part of his time to other duties within the company. His name is Sidney Kelley, a graduate of Stevens Institute of Technology.

Starting to work on July 10, as assistant editor, was Leon Jaroff, who had graduated a few weeks earlier from the engineering school of the University of Michigan.

Now for the coincidence. These two men had been barracks mates in the Naval Radar school at Great Lakes, Ill., for more than two months. That was back in 1945. Neither had seen nor heard of the other during the intervening five years until they met again in this office.

Building a Staff

With the two additions of whom we spoke, the M&M staff is now up to full strength. And now, if we get any cooperation at all from Uncle Joe, we will be able to serve you better than ever. Incidentally, with the latest addition we now have three graduates of the University of Michigan on our staff. This situation led one wag, in the person of Fred Peters, former editor, to remark that the second initial of our name might now stand for Michigan, giving us the corrupted name of *Materials & Michigan.*

No Help

All competition in selling does not necessarily come from your business rivals. On a recent visit to Alcoa headquarters, I was told of some of the difficulties of selling pipe to farmers for irrigational purposes on truck farms. It seems that certain users of aluminum pipe were asked to recommend the pipe to neighboring farmers. In most cases the recommendations were negative. Unable to understand a complete reversal of attitude, one salesman asked one of his customers, "How come?"

"That's easy," he was told, "I compete with those guys, and if they aren't smart enough to find out things like this for themselves, I'm certainly not going to tell them."

New Literature

Several pages forward from here we present an extremely valuable section known as the "Manufacturers' Literature Department." We know it is useful by the number of requests we get for the literature described there. By the way, this is an opportune time to explain that we here at MATERIALS & METHODS do not have a supply of the literature reviewed. Manufacturers send us a copy of any new literature they publish and this goes into our files. We merely serve as a clearing house for readers who request copies. As requests come into this office, they are forwarded to the manufacturer who, in turn, sends you the literature you ask for.

Country Living

On a recent editorial jaunt through the Midwest, I was again made aware of the niceties of living and working in some small cities. One company that I visited, for instance, owns its own country club, and membership fees for the employees is most reasonable.

A Point of Pride

Theoretically, an editor keeps miles away from the advertising and subscription end of the magazine business. Practically, however, he must work as part of a team that is working toward a common goal. That goal is the publishing of a helpful and valuable magazine that meets the needs of the readers it chooses to serve. We are proud to report that we are apparently coming closer to the goal we have set, for we now have more readers than ever. For the first time in our history, our paid circulation passed the 18,000 mark in June of this year. Because we aim to continue as slow but steady growth, we invite reader comment as to what kind of editorial information is most needed. Let's hear from you.

Never Is a Short Time

The other day we were slightly unsettled by a truck sign. The sign advertised a product called "Neva-Rust." Underneath came the shocker—"Guaranteed Not to Rust for Six Years."

T. C. Du Mond
Editor